RC2K90INT-1, RC2K90INT-2, RC2KINT

RC2000 Antenna Interface Box

V. 1.10

Contents Subject to Change

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1. Introduction

This document describes a family of products that allow an RC2000 antenna controller to interface with antennas powered by either 90 or 180 volt DC motors (RC2K90INT-1 and RC2K90INT-2) or other motor types (RC2KINT). The RC2000 antenna controller is designed to interface directly with antennas which employ 36-Volt DC motors (8 amps maximum) and single phase pulse type position sensors. When the RC2000 is used with antennas powered by other types of motors an interface box is required.

Three unique interface box configurations are available from Research Concepts. These configurations are designated RC2K90INT-1, RC2K90INT-2, and RC2KINT. All versions of the interface are housed in NEMA 4 type enclosures that are suitable for outdoor mounting.

RC2K90INT-1 and RC2K90INT-2 Interface Boxes

The RC2K90INT-1 and RC2K90INT-2 interface boxes are designed to interface with either 90 volt or 180 volt DC motors. The RC2K90INT-2 interface box employs a pair of DC motor drive modules and supports simultaneous movement about the antenna's azimuth and elevation axis. The RC2K90INT-1 interface box employs a single DC motor drive module and simultaneous azimuth and elevation movement is not supported.

The DC motor drive modules used in these interface boxes provide dynamic braking of the motors and are available in either 120 or 240 VAC input voltage versions. The following table gives the maximum motor horsepower as a function of AC input voltage and motor voltage.

Input Voltage	Motor Voltage	Maximum Motor Horsepower
120 Volts AC	90 Volts DC	1 1/2 horsepower
240 Volts AC	90 Volts DC	1 1/2 horsepower
220 Volts AC	180 Volts DC	3 horsepower

When ordering an RC2K90INT-1 or an RC2K90INT-2 interface box please specify the AC line voltage, the DC motor voltage and the motor horsepower, and whether two-speed operation, described later in this section, is required.

RC2KINT Interface Box

The RC2KINT interface box consists of the 2K90INT-2 circuit board mounted in a NEMA 4 type box. The circuit board provides uncommitted relay contact closures to activate motor drive control devices provided by the user.

Polarization Control

The RC2000 antenna controller is designed to directly interface with three wire servo type polarization control devices. An optional daughter board (designated RC2KPOL) can be installed on most RC2000 models which provides an interface to a 24 volt DC polarization control motor (400 ma) which uses a potentiometer for position sense feedback. The RC2KPOL daughterboard is compatible with many Seavey Engineering rotating feeds. All of the interface boxes described here provide contact closures which can be used to provide polarization control for antennas which use motors other than 24 volts DC. For these applications it is necessary to install the optional RC2KPOL daughter board in the RC2000 antenna controller. Please contact Research Concepts for more information.

Dual-Speed Antenna Azimuth and Elevation Movement

The RC2000 antenna controllers use a pulse width modulation scheme to obtain slow speed movement when interfaced to 36 volt DC motors. This pulse width modulation scheme is not compatible with the interface box. When the RC2000 A and C model antenna controllers are used with the interface boxes described here, antenna azimuth and elevation movement occurs at fixed speed(s) - the controller's pulse width modulated speed control system must be disabled (from the keypad). These speed(s) are set by the installer via potentiometers located in the RC2K90INT Interface Box. With Dual-Speed interface boxes, two-speed motion is implemented by using the RC2000A's (former) polarotor output to specify the speed. The polarotor output becomes the speed control bit when the *ROTATING FEED PRESENT?* CONFIG Mode item is set to 1. If polarization control is required with a dual speed interface box, the RC2KPOL option must be the polarization control entity. The RC2000 / 2K90INT system does support Polarotor-servo type polarization control schemes but only when operating with a single-speed interface box. A special version of the RC2000C code implements the dual-speed option.

2. Theory of Operation

The two issues which must be addressed to interface an RC2000 controller to a large antenna is the application of power to the antenna motors and sensing of the antenna's position. Polarization control may also be an issue. Applying power to the antenna will be addressed first.

2.1 Controlling the Motors

Figure 1 shows a schematic representation of a single axis (in this case azimuth) of the antenna control system. The output of the RC2000 on the AZ1 and AZ2 terminals will be +/- 36 volts. When AZIM CCW (east in the northern hemisphere) movement is specified, AZ1 will have the higher voltage, and when AZIM CW (west in the northern hemisphere) movement is specified, AZ2 will have the higher voltage. In a similar fashion, when down movement is specified, EL1 will be at the higher voltage, and when upward movement is specified, EL2 will be at the higher potential. When east movement is specified, current will flow out of the AZ1 terminal of the RC2000, through the dropping RESISTOR, R. The purpose of the dropping resistor is to match the output voltage of the RC2000 (nearly 40 volts) to the voltage rating of the relay coils. The current then continues through STEERING DIODE D1, through the east RELAY COIL, through the EAST LIMIT SWITCH, through the WEST LIMIT SWITCH, and back into the AZ2 terminal of the RC2000. Current flowing through the EAST RELAY COIL will activate the relay and close the EAST CONTACT CLOSURE. This will configure the POWER CONTACTOR to move the antenna in the east direction. When east current flows STEERING DIODE D2 keeps current from flowing through the west RELAY COIL.

When the antenna is within the east limit, the EAST LIMIT SWITCH remains closed. When the east limit is reached, the EAST LIMIT SWITCH will open. When this occurs, STEERING DIODE D3 will keep east current from flowing, but will allow west current to flow. West movement limiting is accomplished in a similar fashion. Note that limit switches are not required. The RC2000 series controllers maintain logical limits based on the position count. Limit switches are pretty cheap insurance, however.

The circuit shown in Figure 1 shows the relay contacts activating power contactors that control the motor drive power. The key part of the circuit outlined in Figure 1 is the use of the AZ1 and AZ2 outputs of the RC2000, the dropping resistor, the relays, steering diodes, and the limit switches to generate contact closures which can be used to control the antenna's azimuth motor.

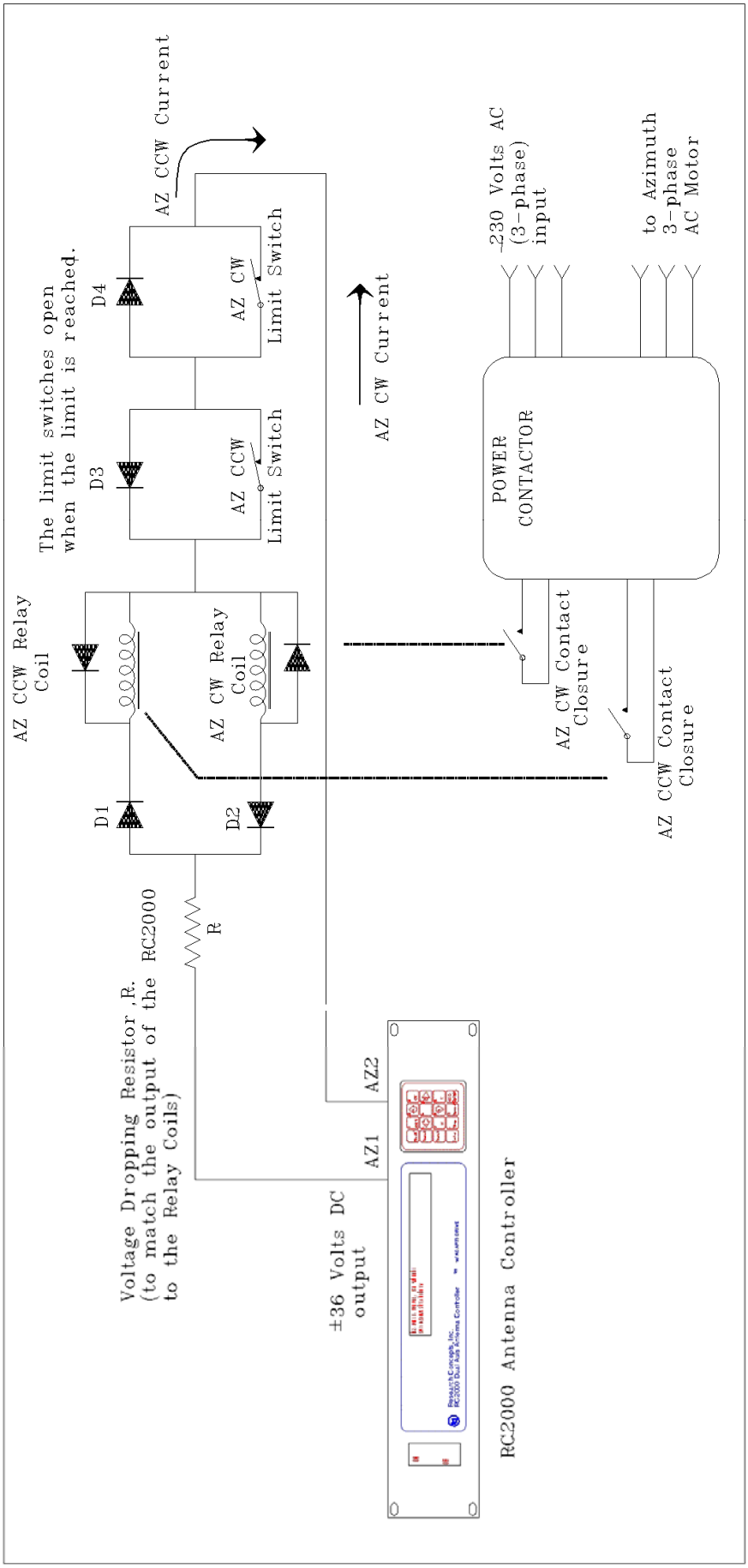

AZ CCW Current
The limit switches open
when the limit is reached.
D4
AZ CW
Limit Switch
D3
AZ CCW
Limit Switch
AZ CW Current
230 Volts AC
(3-phase)
input
to Azimuth
3-phase
AC Motor
POWER
CONTACTOR
AZ CCW Relay
Coil
AZ CW Relay
Coil
D1
D2
AZ CW Contact
Closure
AZ CCW Contact
Closure
Voltage Dropping Resistor,R.
(to match the output of the RC2000
to the Relay Coils)
R
AZ2
AZ1
±36 Volts DC
output
RC2000 Antenna Controller

Figure 1.

Note that the scheme shown in Figure 1 does not support slow speed movement. RC2000 antenna controllers normally vary motor speed by rapidly switching the 36 volt antenna drive signals off and on - which gives an average voltage of less than 36 volts. If this pulse width modulated signal is applied to the circuit of Figure 1, the relays would chatter and produce erratic operation. When using the interface boxes described here with the RC2000, slow speed operation should be disabled on the controller by setting the azimuth and elevation slow speed codes to 254. The single speed of the interface box is adjusted by varying a pot on the drive module(s).

Slow speed movement via the interface box is supported however. The RC2000 software can use the controller's polarotor output to control a relay which provides a pair of contact closures (NO, COM, and NC) which specify fast or slow speed antenna movement. Note that polarotor control is not supported with the RC2000 controller in this mode but polarization control via the optional RC2KPOL daughterboard is still available.

2.2 Position Sensor Interface

The RC2000 series of antenna controllers require the use of single phase pulse type sensors to determine the position of the antenna. A pulse type sensor produces a rectangular shaped waveform as the antenna moves about the axis associated with the sensor. The RC2000 antenna controllers are not compatible with quadrature pulse sensors. 5.7 volts DC is available on the back of the RC2000 (at connector J1-11) to provide power for the pulse sensors.

The RC2000 controllers count the number of rising and falling edges of the waveform. The position count is decremented for east (or down) movement and incremented for west (or up) movement. Referring to Figure 2, the waveform's high level should be 4.5 to 5.7 volts, and the low level should be 0.0 to 0.5 volts. The waveform's minimum high or low pulse duration should be at least 10 milliseconds. This means that pulses less than 10 milliseconds long may not be detected by the antenna controller. The maximum number of counts from the antenna's east limit to its west limit should be less than 65000. Remember, each rising edge and each falling edge of the sensor's output waveform is a separate count.

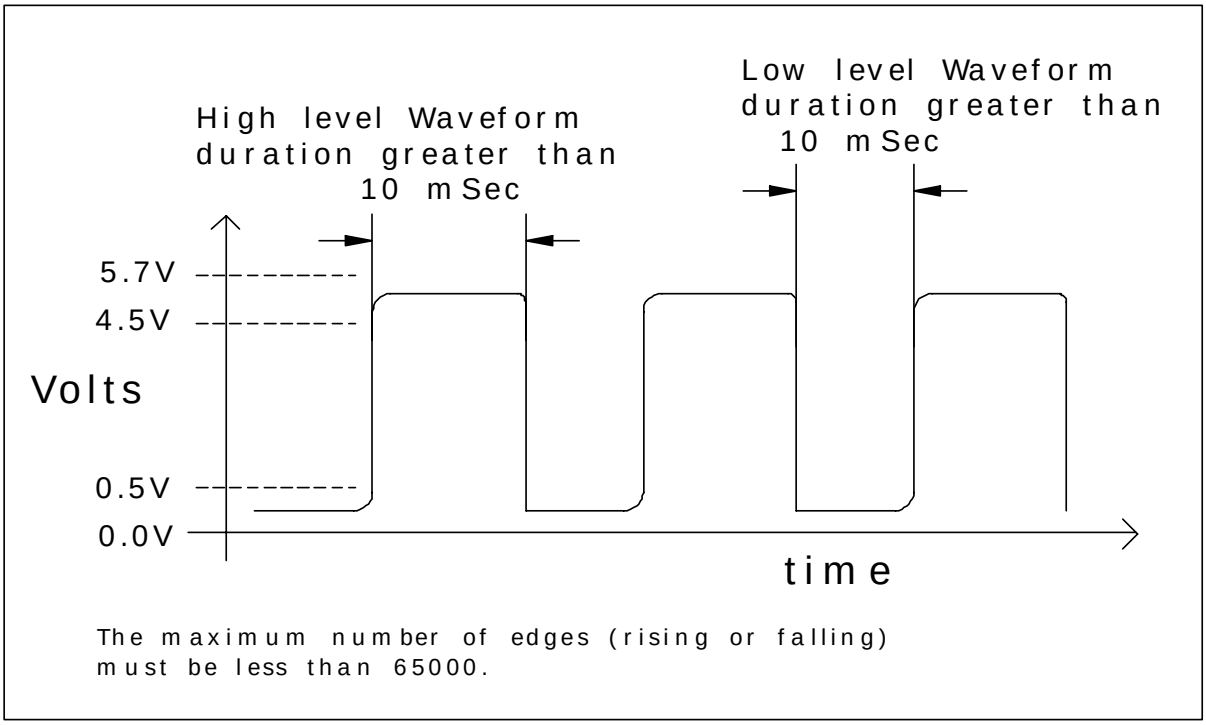


Figure 2.

Many large antennas use a sensor attached directly to each of the fundamental axis of the antenna. The sensor used may be a synchro, potentiometer, or a quadrature pulse encoder. A pulse type sensor attached to the fundamental axis of the antenna is not suitable for use with RC2000 antenna controllers. The reason for this requires a bit of explanation.

When a rising or falling edge is detected on the antenna controller's sensor input, the antenna controller must determine whether to increment or decrement the position count. Since single phase pulse sensors are used, the antenna controller must determine which way the antenna was last commanded to move, and decrement or increment the count accordingly. With a pulse sensor connected directly to the antenna's fundamental axis, when the antenna vibrates back and forth due to wind, the pulse sensor produces a steady stream of pulses. The antenna controller will increment or decrement the count depending on which way the antenna was last commanded to move. In reality the antenna is just vibrating in the wind and not really moving. The result of this is an error in the position count maintained by the antenna controller.

The antenna controllers are designed to work with 36 volt actuators. With these actuators the pulse sensor is connected directly to the motor. The motor typically drives either a worm or screw type gear, which will not transmit wind motion from the antenna back to the motor. Therefore, no false counts are recorded by the antenna controller. By placing a Hall-effect sensor on the shaft of the antenna motors drive, a similar decoupling of wind vibration is achieved. On certain models of the RC2000 it is possible to disable the accumulation of position pulses when the antenna is not commanded to move (or is in a coast interval immediately following the release of the motor drive lines).

2.3 Polarization Control

If the polarization is controlled with something other than a polarotor, then an interface for a polarization motor is necessary. Many popular rotating feeds use a 24 VDC motor with a potentiometer as the position feedback device. These feeds can be driven directly by the RC2000 with the RC2KPOL option (ordered separately). The RC2KPOL drive provides greater than 200mA @ 24 Volts for these feeds. In the event that a high voltage DC or AC motor is used to drive the polarization axis, a scheme similar to that described above for controlling the azimuth and elevation motors can be used with the RC2KPOL option

3. Circuit Description

The interface boxes described in the this document use a common printed circuit board to generate the contact closures (described in the previous section) required to control the azimuth, elevation, and (if needed) polarization axis of the antenna. That printed circuit board is designated 2K90INT-2.

The RC2KINT interface box consists of the 2K90INT board in a NEMA 4 enclosure. The user is responsible for using the contact closures generated by the circuit board to control the antenna.

The RC2K90INT-1 interface box uses a single KBPB motor drive module. The motor drive module accepts AC line voltage and contact closures produced by the 2K90INT-2 circuit board and generates the drive voltage used to power the motors. The motor drive voltage produced by the KBPB motor drive module is routed back onto the circuit board where a latching relay directs the current to either the azimuth or the elevation axis. Simultaneous azimuth and elevation movement is not possible with the RC2K90INT-1 interface box.

The RC2K90INT-2 interface box employs a pair of KBPB motor drive modules. Line voltage is connected to both motor drive modules and each motor is directly connected to a motor module - motor drive voltage does not pass through the 2K90INT-2 circuit board. With the RC2K90INT-2, simultaneous azimuth and elevation movement is permitted.

KBPB DC Motor Drive Module

The RC2K90INT-1 and RC2K90INT-2 interface boxes employ KBPB DC motor drive modules manufactured by KB Electronics, Inc. The KBPB motor drive modules use SCRs to rectify the AC line voltage and control the voltage DC delivered to the armature of the motor being controlled. The KBPB-

125 is designed for use with 120 volt AC line voltage. The KBPB-225 is designed for use with 240 VAC line voltage. These motor drive modules also provide speed control, electronic current limiting, IR compensation, and dynamic braking. A resistor which is installed in the KBPB called the Plug-In Horsepower Resistor matches the KBPB's IR compensation and current limit characteristics to the DC motors used on the antenna. When a KBPB is ordered the horsepower of the motors with which the drive module will be used should be specified so that the correct horsepower set resistor can be installed. When the KBPB-225 is used with 90 volt DC motors a modification is performed to the motor drive to limit the voltage applied to the motors to 90 volts DC. This modification is described in section 4.4. The Operating instructions for the motor drive module(s) are included with the operating manual for the RC2K90INT-1 and RC2K90INT-2 interface boxes.

The line voltage is applied to the L1 and L2 terminals. The polarity of the voltage applied to the motor and the operation of the dynamic brake are controlled by the S1, S2, and S3 connections. When the S2 terminal is not connected to either the S1 or S3 terminals the motor drive is in the brake mode. When S2 is connected to S1 voltage is applied to the armature of the motor (via the A1 and A2 terminals). When S2 is connected to the S3 terminal a voltage of the opposite sense is applied to the motor.

The armature voltage (and the motor speed) can be varied by connecting a potentiometer across the P1 and P3 terminals and applying the voltage present at the wiper of the potentiometer to the P2 terminal. Alternatively, the speed can be controlled by connecting the P2 terminal to the S4 terminal and using the potentiometer located on the KBPB module labeled AUX (or R14) to vary the speed. When the interface box is used with the RC2000D dual speed azimuth and elevation control is available by connecting the terminals on the interface board labeled P1_KBPB1, P2_KBPB1, P3_KBPB1 to the P1, P2, and P3 terminals, respectively, of the KBPB. When used with controllers other than the RC2000D the S4 and P2 terminals of the KBPB are connected together and the azimuth and elevation speed is controlled via the AUX (R14) pot (for this configuration only single speed azimuth and elevation movement is available).

2K90INT-2 Circuit Board

Figure 3 is a schematic of the 2K90INT-2 circuit board. The circuit which includes relays K2 and K3 generates the contact closures required to control the azimuth axis as described in figure 1 above. The azimuth +/-36 volt output of the RC2000 is applied to the terminals labeled AZ1_CTL and AZ2_CTL. The east and west limit switches and their associated steering diodes are connected to the terminals labeled AZLIM1 and AZLIM2. If limit switches are not used a jumper can be connected between the AZLIM1 and AZLIM2 terminals. When east current flows relay K2 activates which in turn connects the terminal labeled S2_KBPB1 to the terminal labeled S1_KBPB1. In a similar fashion, when west current flows relay K3 is activated and the terminal labeled S2_KBPB1 is connected to the terminal labeled S1_KBPB1.

The elevation control circuit consisting of relays K5 and K6 operate in a manner identical to the azimuth circuit. The control signals are applied via the EL1_CTRL and EL2_CTRL terminals. The contact closures associated with these relays are available at terminals S1_KBPB2, S2_KBPB2, and S3_KBPB2.

The polarization control circuit is implemented with relays K7 and K8. The control inputs for this circuit are generated by the an RC2KPOL board installed in the RC2000 antenna controller and are applied to the circuit board via the P1_CTL and P2_CTL inputs. The contact closures associated with polarization control are available at connector J8. The user is responsible for using these contact closures to realize a polarization control scheme for the polarization motors used on his or her antenna.

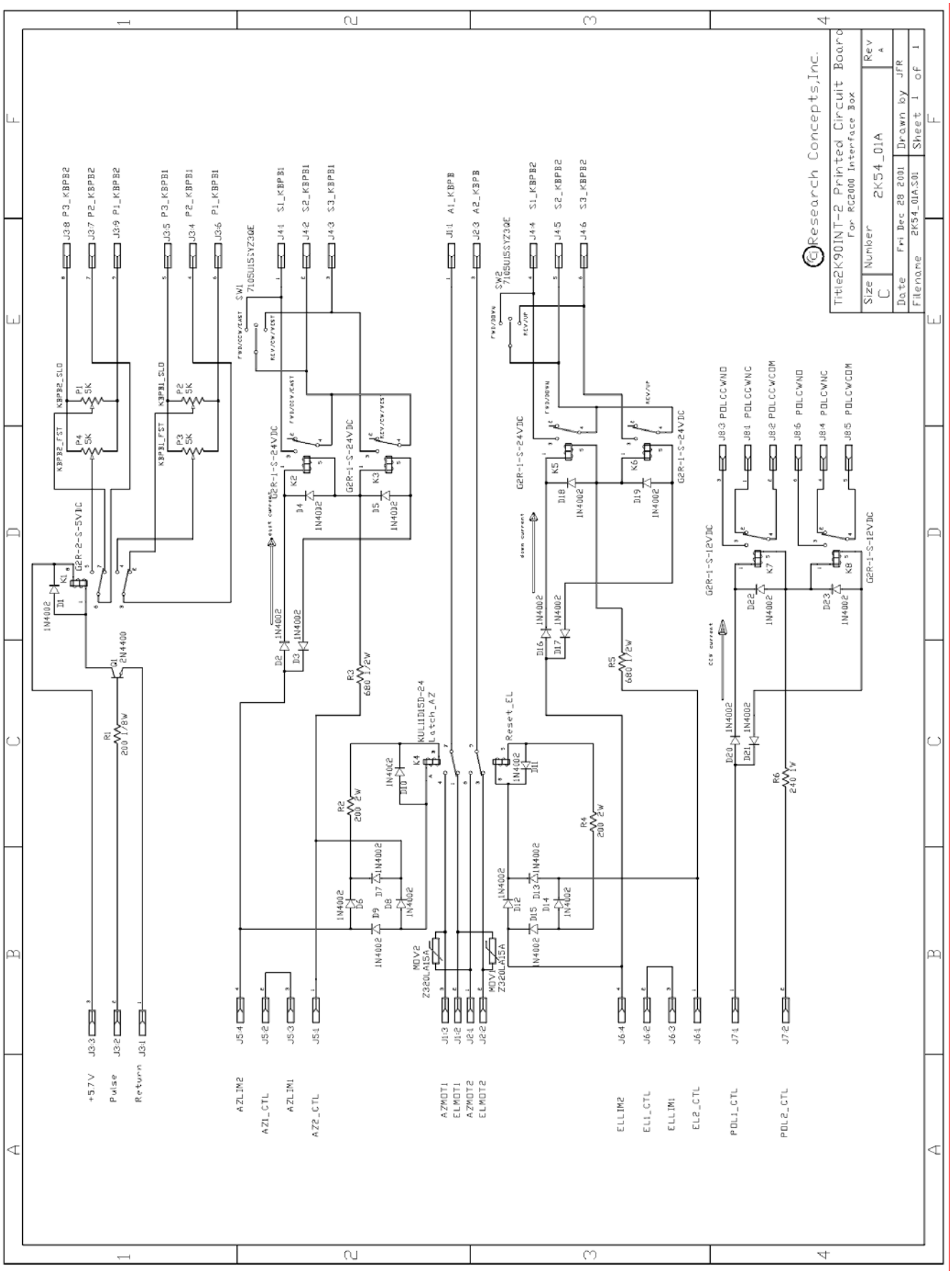

©Research Concepts,Inc.
Title2K90INT-2 Printed Circuit Board
For RC2000 Interface Box
Size C
Number 2K54_01A
Rev A
Date Fri Dec 28 2001
Drawn by JFR
Filename 2K54_01A.SCH
Sheet 1 of 1
+5.7V
Pulse
Return
AZLIM2
AZ1_CTL
AZLIM1
AZ2_CTL
AZMOT1
ELMOT1
AZMOT2
ELMOT2
ELLIM2
EL1_CTL
ELLIM1
EL2_CTL
POL1_CTL
POL2_CTL
Latch_AZ
Reset_EL
G2R-2-S-5VDC
G2R-1-S-24VDC
G2R-1-S-12VDC
2N4400
1N4002
KULI1D15D-24
Z320LA15A
P1_KBPB2
P2_KBPB2
P3_KBPB2
P1_KBPB1
P2_KBPB1
P3_KBPB1
S1_KBPB1
S2_KBPB1
S3_KBPB1
S1_KBPB2
S2_KBPB2
S3_KBPB2
A1_KBPB
A2_KBPB
POLCCWND
POLCCWNC
POLCCWCOM
POLCWND
POLCWNC
POLCWCOM

Figure 3

The circuit associated with latching relay K4 is used by the RC2K90INT-1 interface box. With the RC2K90INT-1 interface box a single KBPB DC motor drive module is present and the latching relay is used to route the motor drive current to either the azimuth or elevation axis. The relay will not be included with the RC2K90INT-2 and RC2KINT model interface boxes. When an azimuth control input signal is applied to the AZ1_CTL and AZ2_CTL inputs the K4 relay coil labeled 'LATCH_AZ' on the schematic is energized and the inputs labeled A1_KBPB and A2_KBPB (connected to the A1 and A2 outputs of the KBPB) are connected to the azimuth motor via the AZMOT1 and AZMOT2 outputs. The diode bridge formed by diodes D6, D7, D8, and D9 insures that an azimuth control signal of either polarity will result in a unipolar voltage being applied to the 'LATCH_AZ' coil of the relay. When the azimuth control signal generated by the RC2000 is removed the latching relay stays in the 'azimuth' position.

In a similar fashion, when an elevation control input signal is applied to the EL1_CTL and EL2_CTL inputs the 'RESET_EL' coil of the K4 relay is energized and the relay contacts are configured to connect the A1_KBPB and A2_KBPB contacts to the elevation motors via the ELMOT1 and ELMOT2 outputs. The diode bridge formed by D12, D13, D14, and D15 allows an elevation drive current of either polarity to activate the 'RESET_EL' coil of the relay. When the elevation control input is removed the relay will stay in the 'elevation' position until an azimuth input is applied. It is necessary to use a latching relay to select the azimuth or elevation axis to support the dynamic braking capability of the motor drive module. If a non latching relay were used, when the control input is removed (for one of the two axis) the relay would switch while the motor is braking (and current is flowing). This would defeat the braking action and generate noise as the relay contacts open with a load applied.

The RC2000D antenna controller supports dual speed azimuth and elevation movement when used with the interface box. With the RC2000D software the controller's polarotor control output may be used to activate relay K1 on the 2K90INT-2 board. This relay provides a pair of speed control channels which can be used with either the KBPB DC motor drive module (in the RC2K90INT-1 or RC2K90INT-2 interface boxes) or a user supplied controller (with the RC2KINT interface box) to obtain dual speed azimuth and elevation movement. When used with other members of the RC2000 controller family only single speed azimuth and elevation movement is available.

The K1 relay is powered with 5.7 volts DC via the terminals labeled +5.7V and Return. 5.7 volts is available at the back panel of the RC2000 antenna controller. To activate the relay (and select high speed movement) 5 volts is applied to the terminal labeled Pulse. Resistor R1 is a dropping resistor on the base of transistor Q1 to limit the voltage at the base to approximately 0.7 volts. When Q1 turns on the relay is activated. The relay provides two speed control channels. Each channel consist of a pair of potentiometers. Only a single channel will be considered. For the KBPB1 speed control channel, the KBPB1_FST and KBPB1_SLO pots (designated P2 and P3, respectively) are connected to the P3_KBPB1 and P1_KBPB1 terminals. When fast speed is selected the voltage at the wiper of the KBPB1_FST terminal is presented to the P2_KBPB1 terminal. When slow speed is selected the voltage on the wiper of the KBPB1_SLO pot is connected to the P2_KBPB1 terminal. If contact closures are required rather than switched potentiometer wipers the potentiometers can be replaced with jumpers.

Diodes D1, D4, D5, D10, D11, D18, D19, D22, and D23 are used to suppress the back emf induced in the relay coils when the relays are de-energized. These are sometimes referred to as 'buck diodes'.

The connection of the 2K90INT-2 circuit board to the KBPB DC motor drive module(s) varies with the type of interface box (RC2K90INT-1 or RC2K90INT-2) as well as the type of controller (the RC2000D software supports dual speed azimuth and elevation movement, other models of the RC2000 controller only support single speed azimuth and elevation movement). The wiring schematics for the various configurations are given in figures 4, 5 and 6.

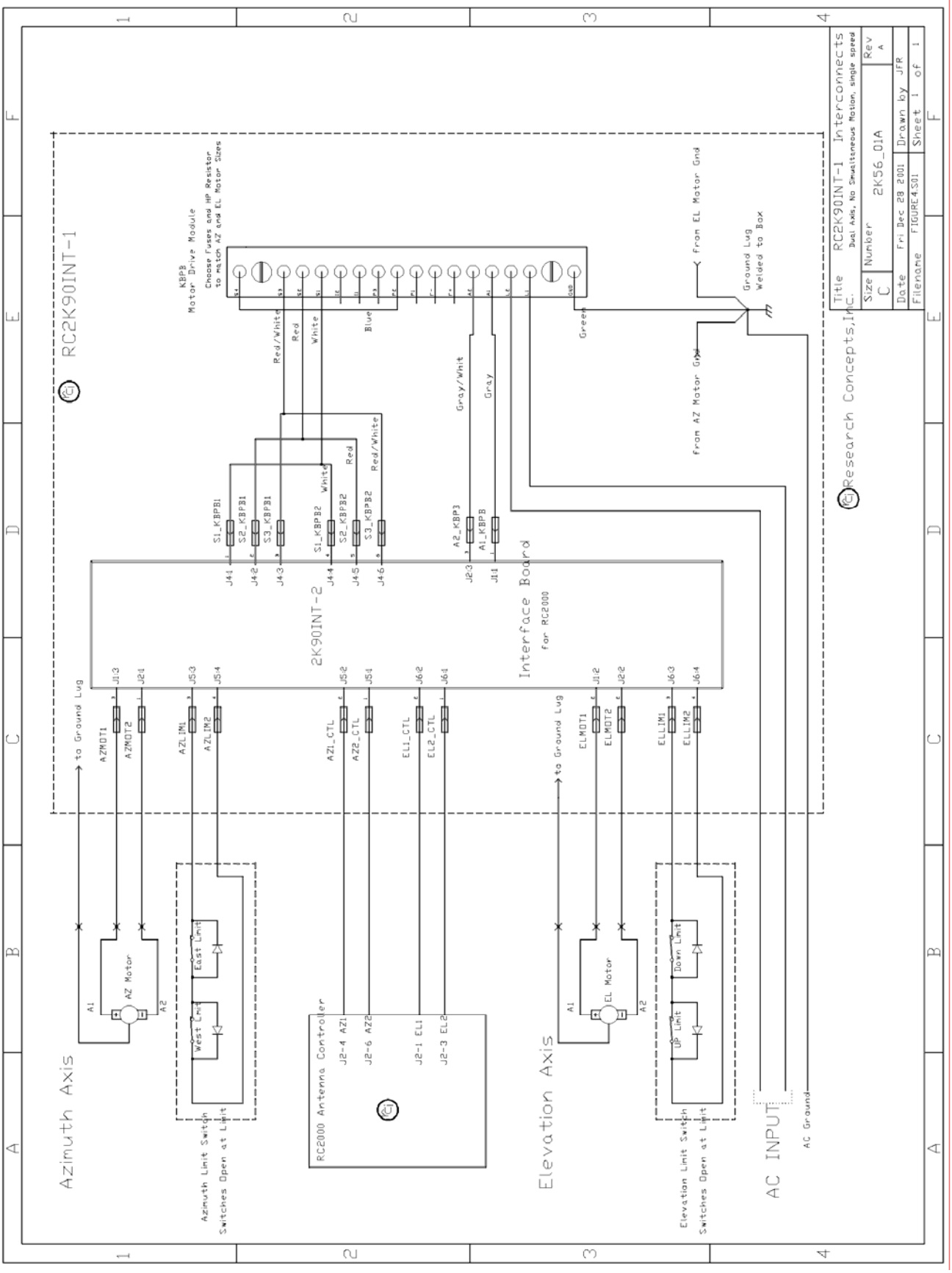

RC2K90INT-1
KBPB
Motor Drive Module
Choose Fuses and HP Resistor
to match AZ and EL Motor Sizes
Red/White
Red
White
Blue
Green
Gray/White
Gray
From EL Motor Gnd
Ground Lug
Welded to Box
From AZ Motor Gnd
S1_KBPB1
S2_KBPB1
S3_KBPB1
S1_KBPB2
S2_KBPB2
S3_KBPB2
A2_KBPB
A1_KBPB
2K90INT-2
Interface Board
for RC2000
to Ground Lug
AZMOT1
AZMOT2
AZLIM1
AZLIM2
AZ1_CTL
AZ2_CTL
EL1_CTL
EL2_CTL
ELMOT1
ELMOT2
ELLIM1
ELLIM2
AZ Motor
East Limit
West Limit
Azimuth Limit Switch
Switches Open at Limit
RC2000 Antenna Controller
J2-4 AZ1
J2-6 AZ2
J2-1 EL1
J2-3 EL2
EL Motor
Down Limit
UP Limit
Elevation Limit Switch
Switches Open at Limit
Azimuth Axis
Elevation Axis
AC INPUT
AC Ground
Research Concepts, Inc.
Title RC2K90INT-1 Interconnects
Dual Axis, No Simultaneous Motion, single speed
Size C
Number 2K56_01A
Rev A
Date Fri Dec 28 2001
Drawn by JFR
Filename FIGURE4.SCH
Sheet 1 of 1

Figure 4

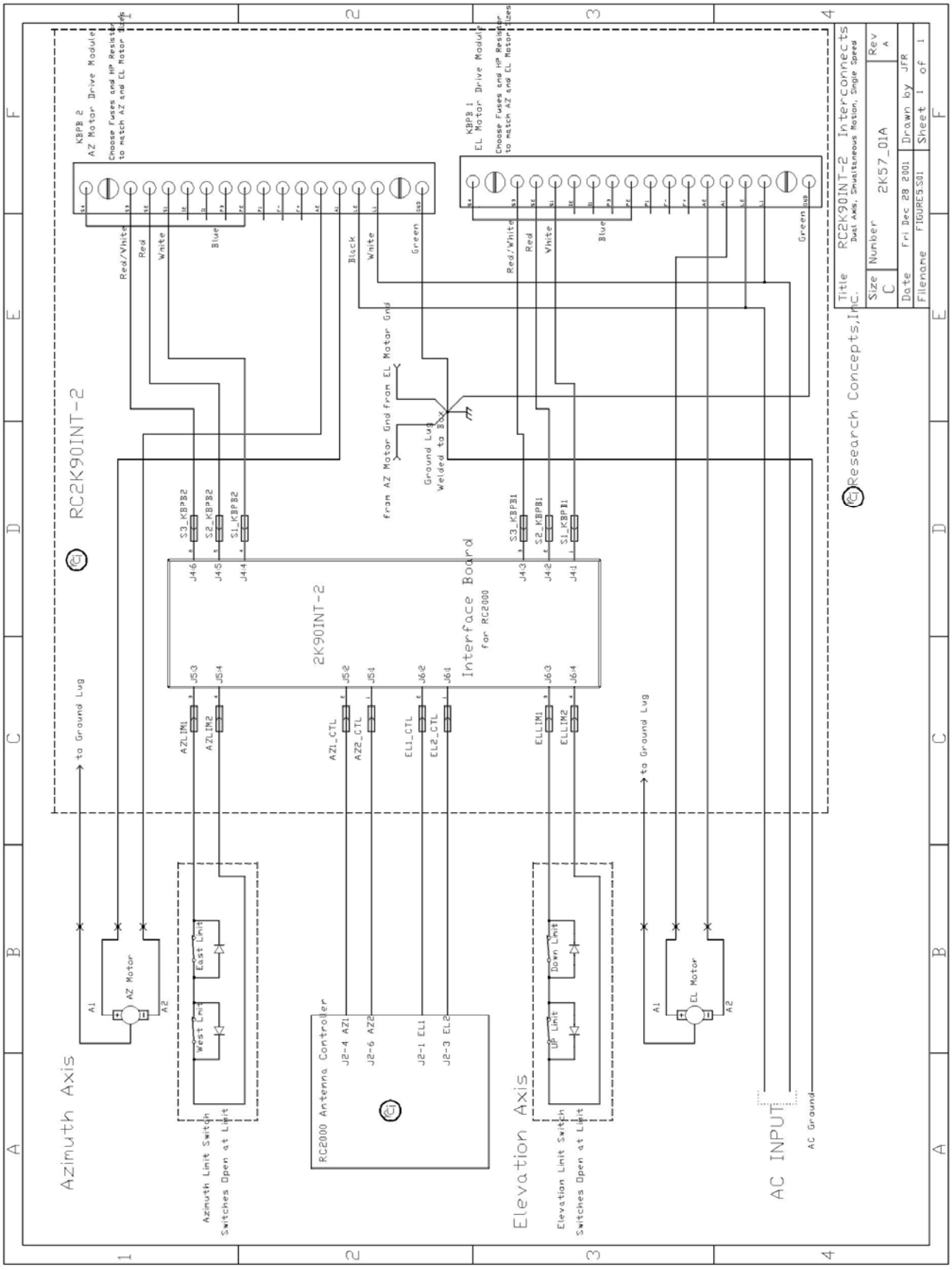

RC2K90INT-2
2K90INT-2
Interface Board
for RC2000
KBPB 2
AZ Motor Drive Module
KBPB 1
EL Motor Drive Module
Choose Fuses and HP Resistor to match AZ and EL Motor Sizes
Red/White
Red
White
Blue
Black
Green
from AZ Motor Gnd from EL Motor Gnd
Ground Lug Welded to Box
S3_KBPB2
S2_KBPB2
S1_KBPB2
S3_KBPB1
S2_KBPB1
S1_KBPB1
J46
J45
J44
J43
J42
J41
J53
J54
J52
J51
J62
J61
J63
J64
AZLIM1
AZLIM2
AZ1_CTL
AZ2_CTL
EL1_CTL
EL2_CTL
ELLIM1
ELLIM2
to Ground Lug
Azimuth Axis
AZ Motor
A1
A2
East Limit
West Limit
Azimuth Limit Switch
Switches Open at Limit
RC2000 Antenna Controller
J2-4 AZ1
J2-6 AZ2
J2-1 EL1
J2-3 EL2
Elevation Axis
EL Motor
Down Limit
Up Limit
Elevation Limit Switch
Switches Open at Limit
AC INPUT
AC Ground
Research Concepts, Inc.
Title RC2K90INT-2 Interconnects
Dual Axis, Simultaneous Motion, Single Speed
Size C
Number 2K57_01A
Rev A
Date Fri Dec 28 2001
Drawn by JFR
Filename FIGURE5.SCH
Sheet 1 of 1

Figure 5

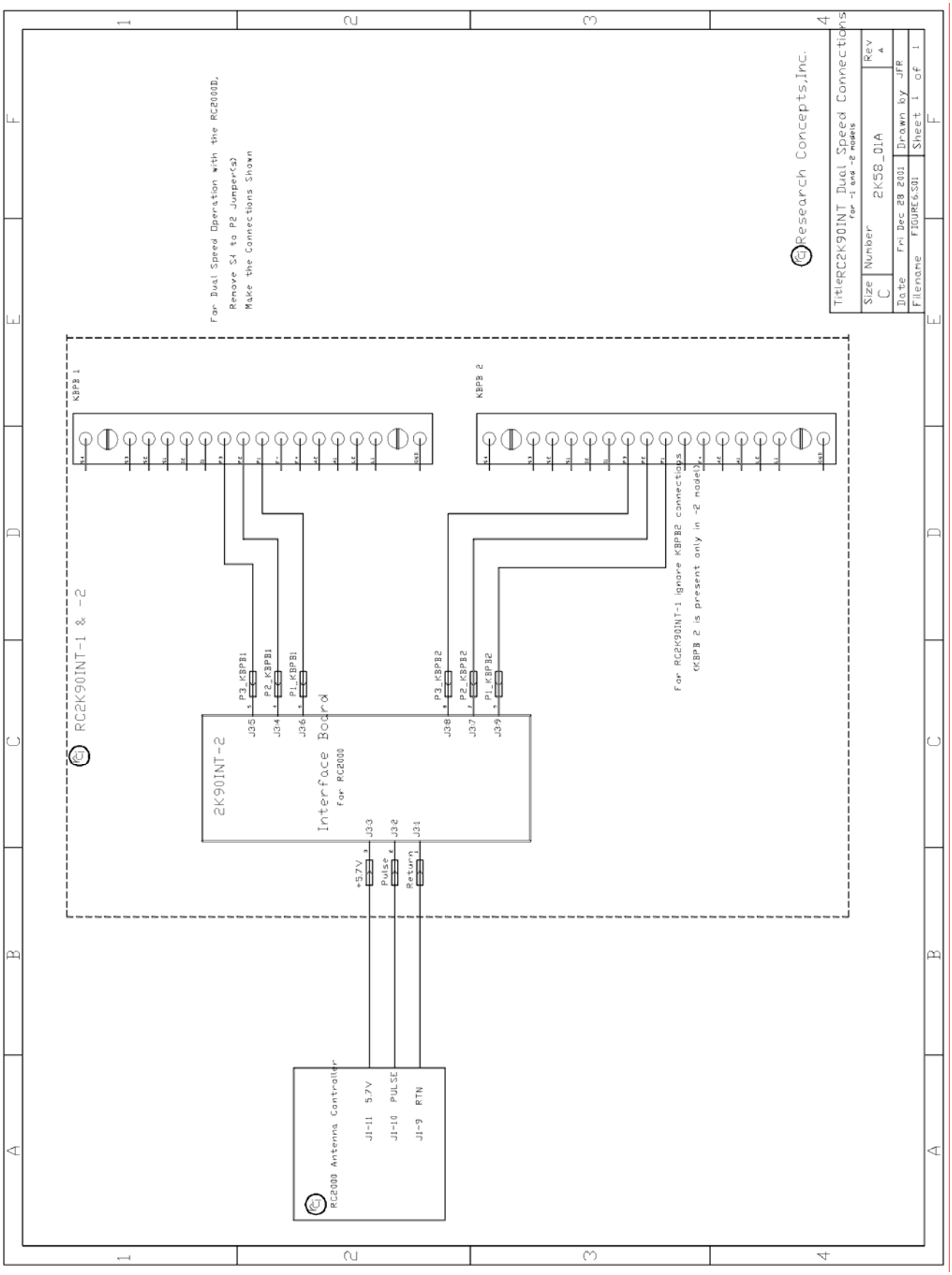

For Dual Speed Operation with the RC2000D,
Remove S4 to P2 Jumper(s)
Make the Connections Shown
©Research Concepts,Inc.
Title RC2K90INT Dual Speed Connections
for -1 and -2 models
Size C
Number 2K58_01A
Rev A
Date Fri Dec 28 2001
Drawn by JFR
Filename FIGURE6.SCH
Sheet 1 of 1
KBPB 1
KBPB 2
RC2K90INT-1 & -2
2K90INT-2
Interface Board
For RC2000
P3_KBPB1
P2_KBPB1
P1_KBPB1
P3_KBPB2
P2_KBPB2
P1_KBPB2
J35
J34
J36
J38
J37
J39
J33
J32
J31
+5.7V
Pulse
Return
For RC2K90INT-1 ignore KBPB2 connections
(KBPB 2 is present only in -2 model)
RC2000 Antenna Controller
J1-11 5.7V
J1-10 PULSE
J1-9 RTN

Figure 6

4.0 Heater Option

A heater option has been developed for the RC2K90INT series of interface boxes. The KB Electronics KBPB Drive used in RCI 90VDC interface boxes has a low temperature rating of 0 C. This is inadequate for most environments. The heater option, designated RC2K90INT-HTR adds a maximum of 100W of heating to the box allowing a no-wind low temp of –50F for the std. 12 x 12x 6 inch interface box.

The Heater option uses a SPST thermostat that turns on at 32°F. Two 115VAC 54W heating pads are wired in series for 230VAC –rated boxed and parallel for 115VAC –rated boxes. The heating pads are attached to the underside of the baseplate with special high-temperature adhesive. the thermostat and heaters are protected with a single fuse in line with the Hot AC input.

5. Installation / Setup

This section describes the installation and setup of the interface box.

5.1 Mechanical Installation

The standard interface box is housed in a 12” by 12” by 6” (height x width x depth) NEMA 4 enclosure. NEMA 4 enclosures are suitable for outdoor use. The interface box is designed to be mounted vertically on the antenna kingpost. The mounting holes are suitable for 1/4 inch screws. The hole pattern is 10” (wide) by 12 3/4” high. The hinge is located on the left side of the box. Six 7/8” holes are punched in the bottom of the box. These holes are designed for 1/2 inch electrical conduit fittings.

Higher power (¾ HP to 1 ½ HP at 115VAC, or 1 ½ HP to 3 HP at 230VAC) versions of the interface box are housed in a 20” by 20” by 8” NEMA4 enclosure. The larger box has a bolt pattern 14” wide by 21 ¼” high.

5.2 Electrical Installation

This sections covers the electrical connections required to connect the interface box to the AC mains, RC2000 antenna controller, and the antenna motors, limit switches, and sensors. Please refer to the wiring diagrams shown in figures 4 and 5. **The AC power to the interface box should be disconnected whenever the interface box is opened - lethal voltages are present inside the box.**

4.2.1 Connecting to the AC Mains

It is the user’s responsibility to provide AC power at the antenna. An AC disconnect which removes all AC power to the interface box **must** be provided **at the antenna**. Each ungrounded AC line supply conductor must be fused. The interface box is available in two versions, one for use with 120 VAC and another for use with 240 VAC. The AC input voltage required is listed on the inside of the box lid. The connection to the AC mains is made directly to the L1 and L2 inputs on the KBPB motor drive module(s) in the smaller configurations (12x12x6 Housing) and to a 16-terminal block in the larger (20x20x8 Housing) configuration. A ground connection must be made to the ground lug located in the upper left hand corner of the box. The capacity of the AC service should be sufficient to carry the load required by the motors. For the RC2K90INT-2 remember that both motors will be running simultaneously.

4.2.2 Connections to the RC2000

A single cable is often used to connect the RC2000 to the interface box. The only connections required for operation of the interface box are those to the RC2000 azimuth and elevation drive outputs. Each axis

requires a pair of conductors. Since the RC2000 motor drive outputs are not actually carrying motor drive current light gauge conductors (16-20 AWG) can be used, shielded cables are not required.

In most cases the cable used to connect the RC2000 to the interface box will also include the conductors required to interface the RC2000 to the azimuth and elevation position sensors. Each sensor requires 3 conductors in a shielded cable with a drain wire. The conductors in the sensor cable don't carry much current, 22 to 18 gauge conductors work fine. In some cases it will be necessary to splice sensor cables in the interface box. Figure 7 is an example of a sensor cable splice.

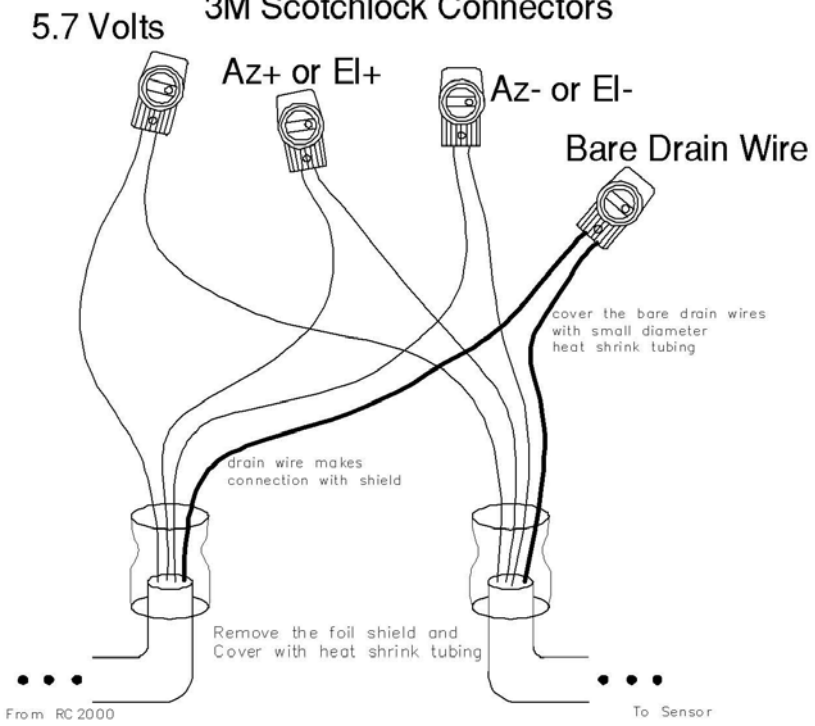
When making sensor connections please note the following ...

- Always use shielded cables.
- The shield drain wire should only be connected at the RC2000.
- If the cable is spliced, be sure to splice the drain wire.
- Don't allow the shield or drain wire to come in contact with ground anywhere. If the cable insulation is cut at a splice put a piece of heat shrink over the frayed shield to keep it from coming in contact with ground.
- Don't connect the drain wire or shield at the sensor.

Failure to follow these guidelines can result in unreliable operation of the pulse counters and antenna controller positioning errors

Shielded Sensor Cable Splice Inside the Interface Box

3-Conductor (with drain-wire)
3M Scotchlock Connectors


5.7 Volts
Az+ or El+
Az- or El-
Bare Drain Wire
cover the bare drain wires with small diameter heat shrink tubing
drain wire makes connection with shield
Remove the foil shield and Cover with heat shrink tubing
From RC 2000
To Sensor

Notes:

1. Make sure that the drain wires are spliced.
2. Do not allow the drain wire or foil to come into contact with ground.
3. Remove the foil shield and drain wire on the sensor end of the cable. Cover the break in the cable so that the shield cannot come into contact with the ground.
4. Use a cable tie for strain relief and to hold the conductors together to minimize the EMI loop area.

Figure 6

.

4.2.3 Antenna Motor and Limit Switch Connections

The motor conductors should be sized appropriately for the motor load. Three conductor cable should be used so that the ground terminal of the motor can be connected to the ground lug in interface box. The limit switch conductors carry very little current, a pair of 20 to 18 gauge conductors are sufficient for the limit switch connections.

5.3 RC2000 CONFIGURATION

Via **CONFIG** mode, the user can optimize the operation of the controller for use with the interface box. Certain **CONFIG** mode items must configured in a certain manner to insure proper operation of the interface box. Other **CONFIG** mode items can optionally be configured so as to optimize the operation of the controller for use with the interface box.

4.3.1 Required CONFIG Mode Settings

A number of RC2000 **CONFIG** mode items must be configured properly for reliable operation of the RC2000 with the interface box. Here is a list of those items ...

CONFIG Mode Item	Required Value for Operation with Interface Box	Comments
Azim Slow Speed	254	A slow speed value of 254 disables the RC2000's pulse width modulation based slow speed system. Failure to properly configure this CONFIG mode item can result in damage to the interface box.
Elev Slow Speed	254	A slow speed value of 254 disables the RC2000's pulse width modulation based slow speed system. Failure to properly configure this CONFIG mode item can result in damage to the interface box.
Simultaneous Az/El Enable	0 - DISABLE	With the RC2K90INT-1, simultaneous azimuth and elevation movement is not allowed. With the RC2K90INT-2, the user will generally want to enable simultaneous azimuth and elevation movement
Az/El Slow Deadband	See the comments.	The value of the Az/El Slow Deadband item should be set to approximately the same value as the Az/El Fast Deadband for interface boxes which only support single speed azimuth and elevation movement. Please see the discussion of these CONFIG mode items in the next section.

4.3.2 Optional CONFIG Mode Settings

The Az/El Drive Options **CONFIG** mode item controls access to the antenna movement parameters. The antenna movement parameters control the movement of the antenna (i.e. the number of attempts which will be made to hit a target position, the maximum allowable error, the coast distances, etc.). The default movement parameters of the RC2000 are optimized for antenna's powered by 36 volt linear actuators. In almost all cases the default values for these **CONFIG** mode items are not appropriate for antennas powered by other types of motors. Most antennas used with the interface box have drive systems with more inertia and more counts per degree of movement than antennas powered by 36 volt linear actuators.

Please refer to the discussion of these **CONFIG** mode items in the RC2000 manual. Failure to properly configure these **CONFIG** mode items can result in inaccurate antenna positioning and/or excessive wear on the motors and actuators.

Two of the **CONFIG** mode items have special features which are often useful in interface box applications. The last two digits of the Az/El Fast Deadband parameter can be configured so as to disable antenna runaway errors. The last two digits of the Az/El Slow Deadband parameter can be configured so as to address the problem of gaps in the program track table which contains a map of an inclined orbit satellite's apparent motion. For a discussion of these features of these two **CONFIG** mode items please refer to the RC2000C manual, Section 7.3 - Operational Troubleshooting Tips.

Many interface box applications are used for inclined orbit satellite uplinks. For transmit applications it is generally advisable to disable the controller's Search Enable **CONFIG** mode item. When the search is enabled, if the antenna is steptracking and the controller's AGC input indicates that the satellite signal has been lost the controller will initiate a search. During a search the controller sweeps the antenna over a parallelogram shaped region where it has calculated that the satellite is likely to be found. This is generally not desirable for transmit applications.

5.4 Interface Box Adjustments

Several user adjustments are available on the KBPB motor drive module and the 2K90INT-2 board located in the interface box. The most common adjustment made is to vary the speed of the motors. On interface boxes made for single-speed antenna movement, the speed is adjusted using R14 on the KBPB motor drive. This pot is labeled 'AUX' or R14. Please refer to the KBPB manual for the location of this pot. **The AC power to the interface box should be disconnected whenever the interface box is opened - lethal voltages are present inside the box.**

4.4.1 Speed Control

For interface boxes configured for dual speed azimuth and elevation movement, the slow speed adjustment pots are located on the 2K90INT-2 circuit board. For the RC2K90INT-1 interface box adjust the KBPB1_SLO pot to vary the slow speed for both the azimuth and elevation axis. Adjust the KBPB1_FST pot to set the fast speed for both axis. For the RC2K90INT-2 interface box the KBPB1_SLO and KBPB1_FST pots are used to adjust the speed of the azimuth axis. The KBPB2_SLO and KBPB2_FST pots are used to adjust the speed of the elevation axis. The maximum and minimum fast and slow speeds for each KBPB are determined by the MAX and MIN trimpots located on each KBPB. Normally the user should not need to adjust these pots - they are set for maximum speed-range when the interface box is assembled.

4.4.2 IR Compensation and Current Limiting

Other trimpot adjustments present on the KBPB are the IR compensation and current limiting. IR compensation is used to increase the voltage to the motor when the motor is loaded so as to maintain a constant speed. Current limiting limits the current applied to the motor. This protects the motor against overloads both while running and at startup. Both of these parameters are controlled via trimpots and with the Plug-In Horsepower Resistor. If the controller was ordered with the proper resistor no adjustment of these trimpots should be necessary. If adjustments are necessary please refer to the KBPB operating instructions included with this manual.

4.4.3 Fusing

The KBPB motor drive module has provisions for a built-in AC line fuse and an Armature Fuse. An AC line fuse of 12 amps is appropriate for 90 VDC motors of up to 3/4 HP and 180 VDC motors of up to 1 1/2 horsepower. For larger motors use a 25 amp AC line fuse. To calculate the size of the armature fuse, multiply the full load DC current rating of the motor by 1.7. Both fuses are normal blow, ceramic type

(Buss type ABC, Littlefuse type 314, or equivalent). For more information on fusing please refer to the KBPB operators manual.

4.4.4 KBPB Modification

If a KBPB-225 (designed for use at 220/240 VAC) is used with 90 volt DC motors the KBPB-225 must be modified to insure that DC voltages greater than 90 volts are not applied to the motor. The model KBPB-225 is used in all interface boxes designed for 220/240 VAC operation. If the customer specifies that the interface box will be used with 90 volt DC motors this modification will be performed when the interface box is assembled. This information is presented here for the case where the KBPB is replaced in the field

Here is the modification: Place a jumper between the A+ and B terminals. These terminals are located on the circuit board near the toroid type transformer. Access to this point is from the same side of the module as where the connector labels are found. The A+ terminal is a .250" quick disconnect type. The B terminal is a .110" quick disconnect type. You can accomplish the same results on late model KBPB-225s by simply placing a J2 jumper in the '90' position. A late model KBPB incorporates surface mount printed circuit board technology. Earlier model KBPB units employ thru-hole printed circuit board technology.

Appendices and Attachments

This section includes the following attachments ...

- KBPB Manual (for model RC2K90INT-1 and RC2K90INT-2 interface boxes)
- A data sheet on the Omron type G2R relay.
- A data sheet on the Potter and Brumfield KUL-11D15D-24 type relay (RC2K90INT-2 only)
- The silk-screen mask of the 2K90INT-2 circuit board
- The bill of materials
- Any appendices related to custom versions of the interface box.

Bill of Materials

Quan	Model/Description	Manufacturer	Comments (Ref Designators)
1	G2R-2-S-5VDC Relay	Omron	DPDT Relay, 5VDC Coil, (K1)
1	P2R-08P Socket	Omron	Socket for DPDT Omron Relay
4	G2R-1-S-24VDC Relay	Omron	SPDT Relay, 24VDC Coil, (K2, K3, K5, K6)
2	G2R-1-S-12VDC Relay	Omron	SPDT Relay, 12 VDC Coil, (K7, K8)
6	P2R-05P Socket	Omron	Socket for SPDT Omron Relay
1	KUL11D15D24	Potter and Brumfield	DPDT Latching Relay, Dual 24VDC Coil (K4)
1	27E046	Potter and Brumfield	Socket for Latching Relay
1	20C247	Potter and Brumfield	Anchor Clip for Latching Relay
23	1N4002	Motorola	Diode (D1-D23)
4	3329H-1-502 Pot	Bourns	5K Ohm, 1 Turn Potentiometer (P1-P4)
1	2N4400 Transistor	Motorola	NPN Transistor (Q1)
1	200 Ohm , 1/8 Watt		Resistor (R1)
2	200 Ohm, 2 Watt		Resistor (R2,R4)
2	680 Ohm, 1/2 Watt		Resistor (R3, R5)

Quan	Model/Description	Manufacturer	Comments (Ref Designators)
1	240 Ohm, 1 Watt		Resistor (R6)
5	150626 Connector	Weidmuller	2 Position Screw Terminal Connector
9	150646 Connector	Weidmuller	3 Position Screw Terminal Connector
2	Z320LA15A	CKE	320 Volt Metal Oxide Varistor (MOV1, MOV2)
2	7105U15SYZ3QE	C & K	SPDT (MOM-OFF-MOM) Switch (SW1, SW2)
1 or 2	KBPB-125 or KBPB-225	KB Electronics, Inc.	DC Motor Drive Module, the KBPB-125 is used with 120 VAC Versions of the Interface Box, the KBPB-225 is used with 220/240 VAC Versions of the Interface Box [2] [3]
2	6-32 x 3/8” Screw		Phillips Head Screw for Latching Relay Socket
2	#6 Lockwasher		Lockwasher for Latching Relay Screw
2	6-32 Small Outline Nut		Nut for Latching Relay Screw
4	??” Standoff		Circuit Board is Mounted on These Standoffs
4	?? Nut w/ Nylon Insert		For Use with Standoff
4	?? Screw		Connects Standoff to the Mounting Panel
2 or 4	?? Screw		KBPB Mounting Screw [1]
2 or 4	?? Washer		Used with KBPB Mounting Screw [1]
2 or 4	?? Lock Washer		Used with KBPB Mounting Screw [1]
2 or 4	?? Nut		Used with KBPB Mounting Screw [1]
1	1414 PHL6LP	Hammond Mfg.	12” x 12” x 6” NEMA 4 Enclosure with Panel[4]
1	1418 N4D8	Hammond Mfg.	20”x20”x8” NEMA4 Encl. w/Panel [4]
4	Insulated Ring Terminal		Crimp Type, #10 Stud, 10-12 AWG Wire Size - Used for Motor and KBPB Chassis Ground Connection

Notes

1 2 are used for the RC2K90INT-1, 4 are used for the RC2K90INT-2

2 Only one motor drive module is used for the RC2K90INT-1, two motor drives are used for the RC2K90INT-2.

3 When a KBPB-225 motor drive module is used with a 90 volt DC motor the KBPB should be modified as described in Section 4.4.4. It is not necessary to perform this modification on new Interface Boxes if 220/240 VAC line voltage and 90 volt DC motors are specified when the interface box is ordered (the modification is performed at the factory).

4 12x12x6 box used up to 3/4HP 115VAC or up to 1 ½ HP 230VAC systems. The 20x20x8 box is used up to 1 1/2HP 115VAC or up to 3 HP 230VAC systems.

Prodelin 3.8 Meter Antenna (Model 1381) Installation Kit

1 Introduction

This document describes an installation kit that is used in conjunction with the RC2K90INT-1 interface box which allows an RC2000C AZ/EL antenna controller to control a Prodelin 3.8 meter antenna (Model 1381).

The following issues are addressed in this paper ...

- The AC power requirements of the interface box.
- Recommended types of cable which may be used to connect the RC2000C antenna controller to the interface box.
- A controller - interface box - antenna wiring diagram.
- RC2000C software configuration parameters.
- A conduit/wiring schedule.
- A Bill of Materials.

2 AC Power

The interface box is housed in a NEMA 4 weatherproof enclosure. When used with a Prodelin 3.8 meter antenna it is mounted on the antenna kingpost on the 'reflector' side of the kingpost. 120/240 Volt AC power must be provided at the antenna pad. All ungrounded AC line supply conductors must be fused or protected with circuit breakers, do not fuse neutral or grounded conductors. 15 or 20 amp circuit breakers are sufficient. In addition, a 120/240 Volt AC emergency disconnect conforming to the NEC (National Electric Code) and other applicable electrical codes must be provided at the antenna and be readily accessible to personnel in the vicinity of the antenna.

The AC line input of the interface box will be prewired with 8 feet of 16/3 cable. The interface box has a straight 1/2" conduit fitting appropriate for flexible steel reinforced liquid tight conduit. The user should make provisions to accept this type of conduit on the electrical box which houses the emergency disconnect. Alternatively, the user can replace the liquid tight conduit fitting with a different type of conduit fitting. The interface box is punched with a 7/8" diameter hole for the liquid tight conduit fitting.

3 Antenna Controller to Interface Box Interconnect Cable

The user must supply the cable to connect the RC2000C to the interface box. On the interface box there is a 1/2" straight liquid tight steel reinforced flexible conduit fitting reserved for mechanically connecting the interconnect cable to the interface box. The conduit fitting has a 1/2" diameter opening which the interconnect cable must pass through to enter the interface. Make sure that the interconnect cable(s) selected will fit through the 1/2" diameter opening. Alternatively, the user can replace the liquid tight conduit fitting with a different type of conduit fitting. The interface box is punched with a 7/8" diameter hole for the liquid tight conduit fitting.

The cable must have 2 pairs of 20 AWG (or heavier) conductors to carry the motor control signals (forward - stop - reverse). Shielded conductors are not necessary for these signals but if shielded conductors are available the shield can be used. For shielded motor control conductors, follow the rules

given below for the shielded sensor cables. In addition to the motor control signals a pair of individually shielded triples with drain wires are necessary for the sensor connections.

Please note the following concerning the interconnect cable and sensor connections ...

- Always use shielded cables for the sensors.
- The shield drain wire should only be connected at the RC2000.
- If the cable is spliced, be sure to splice the drain wire.
- Don't allow the shield or drain wire to come in contact with ground anywhere. If the cable insulation is cut at a splice put a piece of heat shrink over the frayed shield to keep it from coming in contact with ground.
- When splicing the sensor cables please refer to figure 7 in the RC2K90INT-1 manual.

Belden 1083A cable has been successfully used to interconnect the RC2000C to the RC2K90INT-1 interface box. This cable consists of 4 individually shielded triples (or triads). The conductor size is 20 AWG and the shields are equipped with a drain wire. A similar product is available from Olympic Wire and Cable Corp. (part number 9883).

It also possible to use a pair of satellite TVRO 'actuator cables' to connect the RC2000 to the interface box. Actuator cable typically consists of a pair 16 AWG unshielded conductors and a shielded 22 AWG triple with drain wire. This cable is inexpensive and is available from CommScope and others.

The RC2000 to interface box interconnect cable carries DC voltages of 40 volts or less. In the US a direct burial type cable can be used.

4 Making the Connections

The installation kit includes steel reinforced liquid tight flexible conduit and cabling for connection of the interface box to the antenna motors, sensors and limit switches. There are 6 straight conduit fittings on the bottom of the interface box. From the left, these fittings are used for: AC power, the RC2000 interconnect cable, the elevation motor conduit run, the elevation sensor conduit run, the azimuth sensor conduit run, and the azimuth motor conduit run.

There are six conduit runs which are used to connect the interface box to the antenna. The following table describes the conduit fitting types, conduit lengths, and cable types and lengths

Description of Conduit Run	Conduit Run Starting Point and Conduit Fitting Type	Conduit Length	Cable Type/Length	Conduit Run Termination Point and Fitting Type
Azimuth Motor	Interface Box, Straight Fitting	130 Inches	16/3 - 140 Inches	Azimuth Motor, 90 Degree Fitting
Azimuth Sensor	Interface Box, Straight Fitting	113 Inches	18/2 - 170 Inches, Belden 8772 - 124 Inches	Azimuth Sensor, 45 Degree Fitting

Description of Conduit Run	Conduit Run Starting Point and Conduit Fitting Type	Conduit Length	Cable Type/Length	Conduit Run Termination Point and Fitting Type
Azimuth Limit Switch	Azimuth Sensor, 90 Degree Fitting	31 Inches	The Continuation of the 18/2 Cable Described in the Previous Entry.	Azimuth Limit Switch, Straight Fitting. Note: A 1/2" to 3/4" Conduit Bushing is Required at the Limit Switch
Elevation Sensor	Interface Box, Straight Fitting	120 Inches	18/2 - 160 Inches, Belden 8772 - 130 Inches	Elevation Sensor, 90 Degree Fitting
Elevation Limit Switch	Elevation Sensor, Straight Fitting	12 1/2 Inches	The Continuation of the 18/2 Cable Described in the Previous Entry	Elevation Limit Switch, 90 Degree Fitting. Note: A 1/2" to 3/4" Conduit Bushing is Required at the Limit Switch
Elevation Motor	Interface Box, Straight Fitting	105 Inches	16/3 - 120 Inches	Elevation Motor, 90 Degree Fitting

The antenna will be shipped with four flexible conduit runs (with wire pulled through the conduit) to the elevation motor, elevation sensor, azimuth sensor, and azimuth motor attached to the interface box. The installer will have to attach these conduit runs to the elevation motor, elevation sensor, azimuth sensor, and azimuth motor. The two other conduit runs (elevation sensor to elevation limit switch conduit run and the azimuth sensor to the azimuth limit switch conduit run) will be included with the interface box but not attached to anything - the installer will have to place these. The Teflon tape included with the installation kit can be used on any conduit fitting which cannot accept a sealing gasket or O ring (such as the 1/2" to 3/4" bushing used on the limit switches).

Once the conduit has been attached the wiring connections can be made.

The installer must make the following connections (please refer to figures P1 and P2).

1. The RC2000 to Interface Box Interconnect cable must be installed. Make the connections at the RC2000. Refer to Chapter 3 in the RC2000 manual for more information on the connection at the RC2000.

2. The motor control signals on the RC2000 to Interface Box interconnect cable must be attached to the AZ1_CTL, AZ2_CTL, EL1_CTL, and EL2_CTL terminals on the circuit board in the interface box.

3. The sensor cables in the RC2000 to Interface Box interconnect cable will have to be spliced to the Belden 8772 cable in the interface box. Please reread section 3 of this manual and refer to figure 7 in the RC2K90INT-1 interface box manual before making the splice. Use the 3M Scotchlok connectors to make the splice. Proper connection of the sensors is critical to the operation of the antenna controller.

4. Connect the sensor cables to the sensors (refer to figure P1). At the sensors, cut off the drain wire and place a piece of heat shrink tubing over the sensor cable where the insulation is cut so that the shield

does not come in contact with the sensor housing. Use the 3M Scotchlok connectors to make the connections.

5. At the azimuth and elevation motor terminal boxes, connect the 16/3 cables to the motor lead wires (refer to figure P1). Use the butt type crimp connectors to make the connections. The motor input leads are labeled A1 and A2. The green wire is the motor ground wire.

6. At the azimuth and elevation limit switches connect the 18/2 cables to the limit switches (refer to figure P2). The diodes and the jumper should be installed. Use the spaded terminals for these connections.

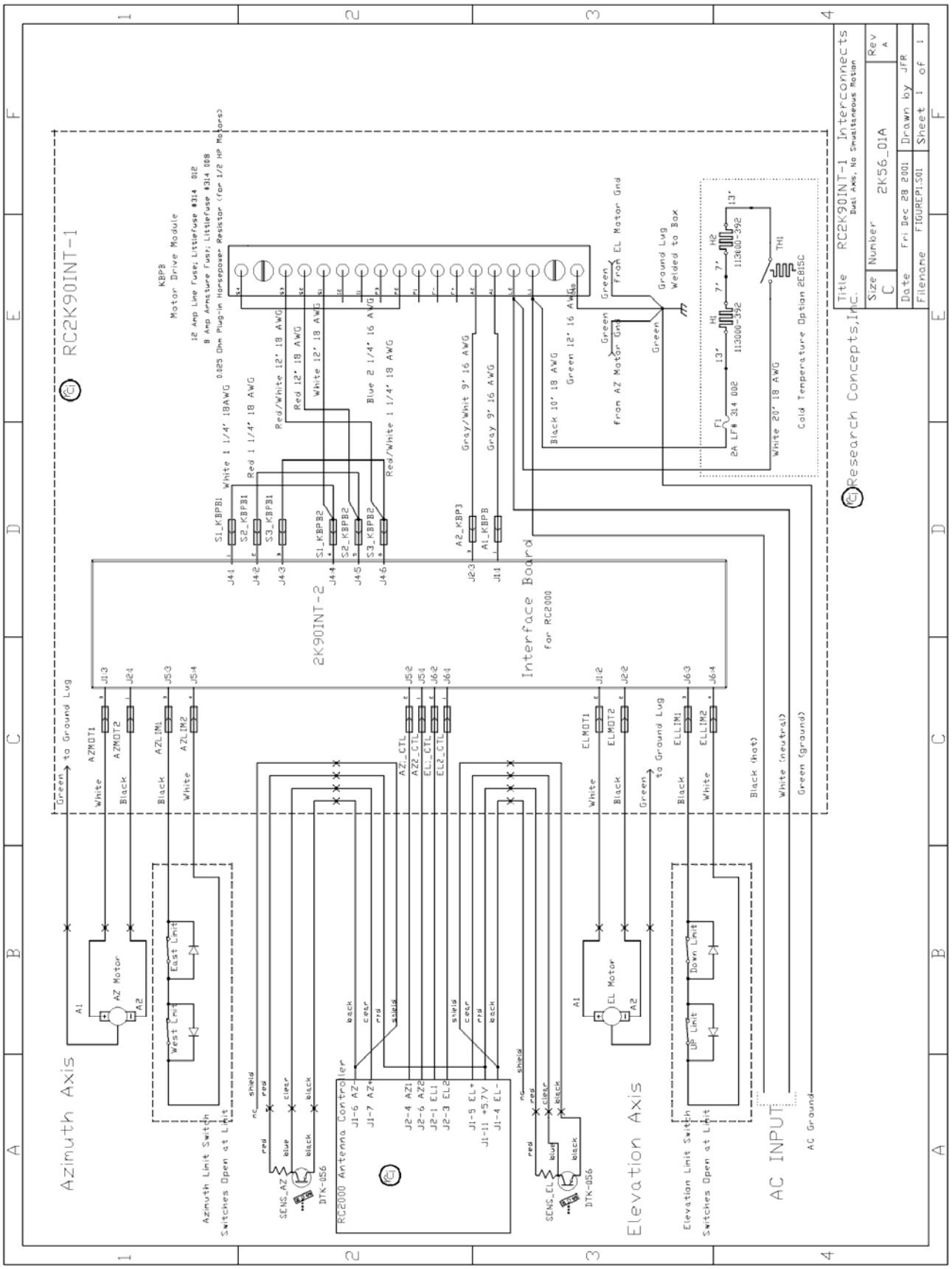

RC2K90INT-1
2K90INT-2
Interface Board
for RC2000
KBPB
Motor Drive Module
12 Amp Line Fuse; Littlefuse #314 012
8 Amp Armature Fuse; Littlefuse #314 008
0.025 Ohm Plug-in Horsepower Resistor (for 1/2 HP Motors)
Azimuth Axis
Elevation Axis
AC INPUT
AC Ground
AZ Motor
EL Motor
East Limit
West Limit
Down Limit
UP Limit
Azimuth Limit Switch
Switches Open at Limit
Elevation Limit Switch
Switches Open at Limit
RC2000 Antenna Controller
SENS_AZ
SENS_EL
DTK-056
Green to Ground Lug
Black (hot)
White (neutral)
Green (ground)
Ground Lug
Welded to Box
from EL Motor Gnd
from AZ Motor Gnd
2A LF# 314 002
Cold Temperature Option 2E815C
Research Concepts, Inc.
Title RC2K90INT-1 Interconnects
Dust AXIS, No Simultaneous Motion
Size C
Number 2K56_01A
Rev A
Date Fri Dec 28 2001
Drawn by JFR
Filename FIGURECP1.SCI
Sheet 1 of 1

Figure P1

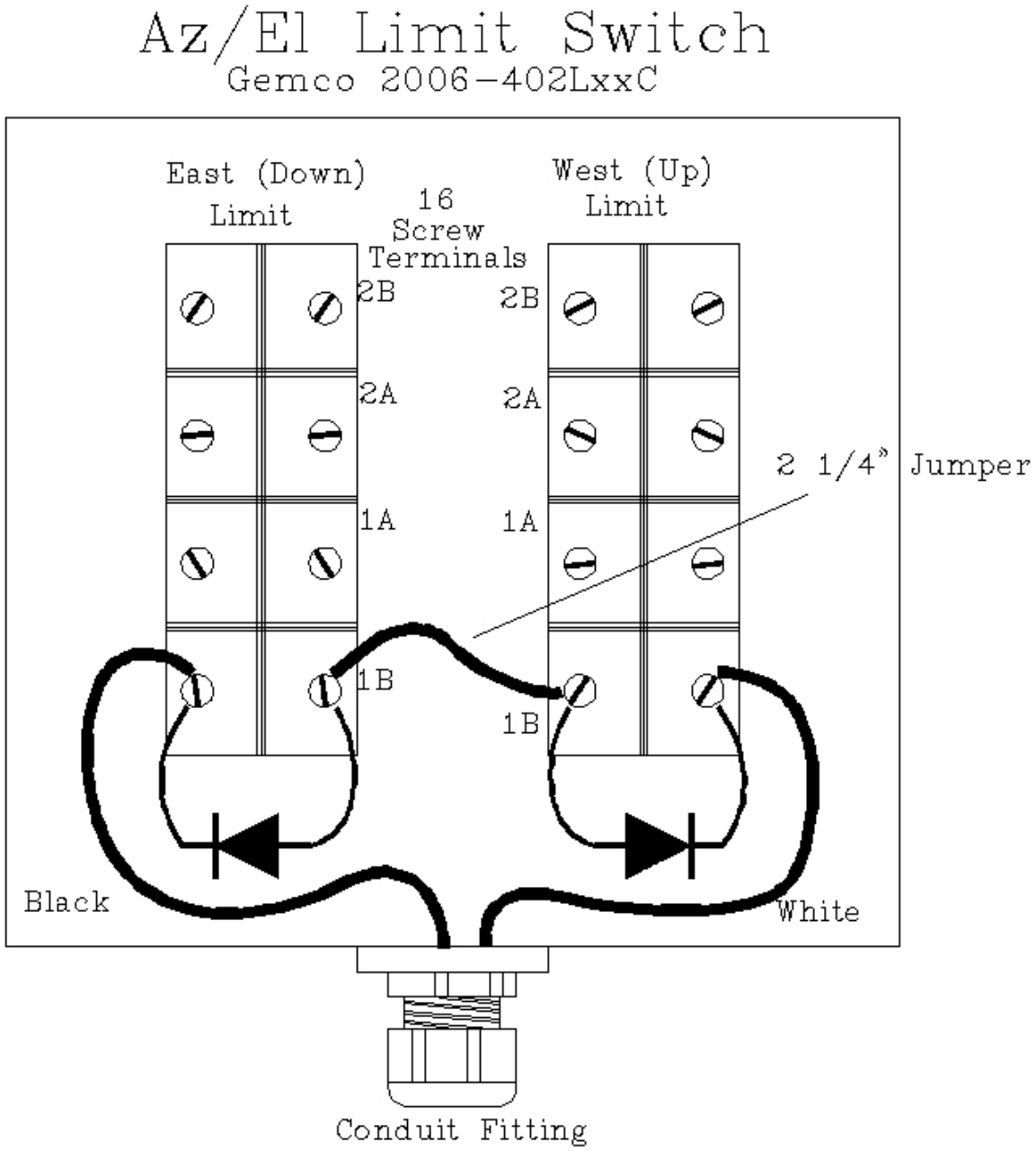

Az/El Limit Switch
Gemco 2006-402LxxC
East (Down)
Limit
16
Screw
Terminals
West (Up)
Limit
2B
2A
1A
1B
2B
2A
1A
1B
2 1/4" Jumper
Black
White
Conduit Fitting

Figure P2

When all this has been completed connect the interface box to AC power. Please refer to section 2 for information concerning the AC hookup.

5.0 RC2000 Software Configuration

The RC2000 stores certain parameters and configuration data in non-volatile memory. These parameters are viewed and modified via the controller's CONFIG mode and are referred to as CONFIG mode items. Some CONFIG mode items contain information which optimize the controller's auto move algorithms to the electromechanical drive system employed by the antenna. Other CONFIG mode items signal the controller as to what type of equipment the RC2000 is interfaced with. The values assigned to the following CONFIG mode items are appropriate for the Prodelin 3.8 meter (Model 1381) antenna without polarization control. For more information on the purpose of these CONFIG mode items please consult the RC2000 antenna controller manual.

CONFIG Mode Item	Required Value for Operation with Prodelin 3.8 meter antenna	Comments
AutoPol Enable	0 – DISABLE	AutoPol disabled.
Simultaneous Az/El Enable	0 – DISABLE	The RC2K90INT-1 does not support simultaneous azimuth and elevation movement.
Azim Slow Speed	254	A slow speed value of 254 disables the RC2000's pulse width modulation based slow speed system. Failure to properly configure this CONFIG mode item can result in damage to the interface box.
Elev Slow Speed	254	A slow speed value of 254 disables the RC2000's pulse width modulation based slow speed system. Failure to properly configure this CONFIG mode item can result in damage to the interface box.
Rotating Feed Present	0 – NO	When this CONFIG mode item is set to zero the controller assumes that a 3 wire servo type polarization control device is present. This is also the correct setting when there is no polarization control device. A servo type polarization control device provides no position feedback to the controller - the controller cannot tell whether a servo type polarization control device is connected or not. Note that the user will be prompted to specify H and V polarizations in SETUP and AUTO modes. In SETUP mode just use the CW/CCW keys to adjust the polarization position to 50, hit the H key and then the V key. In AUTO mode select either H or V - it makes no difference which one is selected.
Az/El Drive Options Enable	1 – ENABLE	When this CONFIG mode item is enabled the user has access to the Az/El Fast Slow Threshold, 'Auto Retry Attempts, 'Fast and Slow Deadband, Azim and Elev Coast Thresholds, and Azim and Elev Max Position Error CONFIG Mode items.
Az/El Auto Retry	2	The controller will make 2 attempts to get within 'Max

CONFIG Mode Item	Required Value for Operation with Prodelin 3.8 meter antenna	Comments
Attempts		Position Error counts of a target position.
Az/El Fast Deadband	4000 milliseconds	The controller will allow 4 seconds for the antenna to coast to a stop. If RUNAWAY errors occur the value of this parameter can be set to 4001 to disable the accumulation of counts when the antenna is not commanded to move or is not coasting to a stop. This will disable the RUNAWAY error.
Az/El Slow Deadband	4023 milliseconds	The controller will allow 4 seconds for the antenna to coast to a stop. The last two digits ('23') tell the controller to not schedule a peakup when Step Tracking within 230 seconds of a time corresponding to a Program Track table entry. This prevents 'holes' from occurring in the program track table. See the troubleshooting section of the RC2000 manual for more information.
Azim Coast Threshold and Elev Coast Threshold	14 position counts	When moving towards a target position in either azimuth or elevation, the controller will turn off the motors when the position reaches a point 14 counts away from the target position. The idea is that the antenna will coast into position.
Azim Max Position Error and Elev Max Position Error	8 position counts	This parameter is used when the controller is attempting to automatically move the antenna in azimuth or elevation to a target position. If (after a move) the resting position of the antenna is greater than 8 counts from the target position the controller will initiate another auto move to attempt to hit the target position if the number of retry attempts initiated so far is not greater than that specified by the Az/El Auto Move Retry Attempts CONFIG mode item.
Antenna Size	380 centimeters	
Azim Constant	17492 counts per radian	This is the approximate number of position counts per radian of antenna azimuth movement. This corresponds to 305 azimuth position counts per degree.
Elev Constant	33615 counts per radian	This is the approximate number of position counts per radian of antenna elevation movement. This corresponds to 587 elevation position counts per degree.
Max Track Error	5 tenths of a dB	
Search Enable	0-DISABLE	For transmit applications the search feature should be disabled. Please see the description of TRACK mode in the RC2000 manual for more information.

6 Bill Of Materials

Quan	Model/Description	Manufacturer	Comments (Ref Designators)
50’	LA11-50	Electri-Flex	1/2” Liquid Tight Steel Core Flexible Conduit
8	GY-4Q-50	Oz/Gedney	1/2” Straight Conduit Connector
5	GY-4Q-950	Oz/Gedney	1/2” 90 Degree Conduit Connector
1	GY-4Q-450	Oz/Gedney	1/2” 45 Degree Conduit Connector
2	KKR-21	Killark	3/4” to 1/2” Conduit Bushing
1			1/2” Teflon Tape (for conduit fittings)
24’	8772 cable	Belden	3 conductor shielded cable with drain 20 AWG
25’	01306	Carol	16/3 Motor Connect Cable
32’	13002	Carol	18/2 Limit Switch Connect Cable
6	Butt Connector		Crimp Type, Insulated, 16-14 AWG for Motor Connections
16	Spade Terminal		Crimp Type, Insulated, 22-16 AWG for Limit Switch Connections
14	UR Connector	3M	Red Scotchlok with dielectric grease
16”	FIT-221-3/64	Alpha	3/64” heat shrink - Covers Drain Wire at Sensor Cable Splice
8”	FIT-221-1/4	Alpha	1/4” heat shrink - Covers the Break in the Insulation at the Sensor Cable (Belden 8772) Splice
6”	FIT-221-3/8	Alpha	3/8” heat shrink - Covers the Break in the Insulation at the Sensor Cable (user supplied) Splice
8	4” cable tie		Tie for Sensor Cable Splice
10	6” cable tie		Tie for General Use Inside Interface Box
10	8” cable tie		Tie Used to Join Azim/Elev Motor and Sensor/Limit Conduits (Weather Proof and Ultraviolet Resistant)
12	9772	Dell City Wire Co.	Adhesive Cable Tie Point
2	GI752	General Instrument	High Current Steering Diode for Limit Switches
2	2 1/2” Jumpers, 16 AWG		For Use in Limit Switches
1	Tube of RTV Sealer		Used for Misc. Sealing
2	314 012	Littlefuse	12 Amp Ceramic AC Line Fuse for KBPB [**1**]
2	314 008	Littlefuse	8 Amp Ceramic Armature Fuse for KBPB [**1**]
1	9841	KB Electronics, Inc.	0.025 ohm Plug-In Horsepower Resistor for KBPB-225 Motor Drive Module. This appropriate for use with the Baldor CDP 3330 1/2 Horsepower, 1750 RPM 90 volt DC motors used on the Prodelin 3.8 meter antenna.

Note: These fuses are equivalent the Buss type ABC (normal blow, ceramic).

7 Installation Checklist

Before the installation, the following items should be addressed....

1. Fused AC power with a local disconnect must be present at the antenna pad. The installation should conform to the NEC (National Electric Code) or any other applicable codes. Please refer to section 2 - AC Power. The user is responsible for getting the AC power to the interface box - make provisions for any conduit or fittings which may be needed.

2. The installer must obtain and route the RC2000 to interface box interconnect cable. The RC2000 is designed for rack mounting indoors and can be powered by either 110 or 220/240 VAC. Please refer to section 3 for the specification of the interface cable. The user is responsible for any conduit or fittings required to route the interface cable to the interface box.

3. The RC2000C Az/El Inclined Orbit Satellite Tracking Antenna Controller requires an analog voltage input which is proportional to the satellite signal strength. The range of the AGC input voltage is 0 to 10 volts. The RC2000 can accept two channels of AGC signal strength information and has gain and offset pots for each channel. This allows the RC2000 to work with any analog voltage which swings over any part of the 0 to 10 volt input range. The controller can be configured via software to accept negative polarity AGC inputs (i.e. a strong received signal corresponds to a smaller analog voltage).

8 Tools and Materials Required For Installation

- Wiring Tools: wire cutters, wire stripper, crimp connector crimp tool.
- Heat gun or a lighter for use with heat shrink tubing.
- Hack saw for cutting liquid tight steel reinforced conduit.
- A fine straight bladed screwdriver for use with the AGC GAIN and OFFSET pots and the screw terminals on the circuit board in the interface box (tip 0.1” inch wide x .03” thick). A jewelers screw driver set may include these sizes.
- Phillips and straight bladed screwdrivers for gaining access to the interface box , the terminal boxes on the sensors, limit switches, and motors.
- A 12” Crescent wrench for working with the conduit fittings.
- Channel Lock pliers for working with conduit fittings. A regular set of pliers for use with the 3M Scotchlok connectors.

9 Attachments

Pulse Sensor Data Sheet (Dart CF-H1 or Powermation DTK-056M1

Limit Switch Data Sheet (Elevation Limit Switch - Gemco 2006-402L60C, Azimuth Limit Switch - 2006-402L30C)

A Note

Thank you for your support of our products. We appreciate your comments. If you find errors or omissions in this manual or any deficiencies in our products please contact us.

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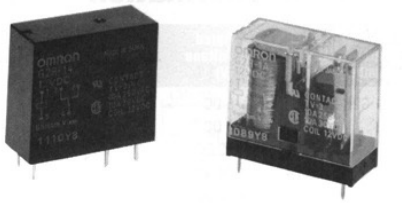
Website: www.researchconcepts.com

G2R

Power PCB Relay

Features

- Slim-styled power relay – available in both latching and non-latching types
- Creepage distance of 7.874 mm (.31 in.) min. between coil and contact
- Single and dual-winding latching types available
- Plug-in and Quick-connect terminals available
- High-sensitivity (360mW), high capacity (16 A) and bifurcated contact types available
- Highly stable magnetic circuit for latching endurance and excellent resistance to vibration and shock
- Safety-oriented design assuring high surge resistance (15,000 V min. between coil and contact with the single-winding type; 10,000 V min. between coil and contact with the dual coil type)



Contact Data

Contact ratings

One-pole:

General purpose: 10 A, 250 VAC, 30 VDC (Resistive); 7.5 A, 250 VAC, 5 A, 30 VDC (Inductive); 3 A, 120 VAC, Tungsten (TV-3); 1/3HP, 120 VAC; 1/2HP, 250 VAC; 1/2HP, 277 VAC

High-capacity: 16 A, 250 VAC, 30 VDC (Resistive); 8 A, 250 VAC, 30VDC (Inductive); 3 A, 120 VAC, Tungsten (TV-3); 1/3HP, 120 VAC; 1/2HP, 250 VAC

High-sensitivity: 5 A, 250 VAC, 30 VDC (Resistive); 2 A, 250 VAC, 3 A, 30 VDC (Inductive)

Latching: 5 A, 250 VAC, 30 VDC (Resistive); 3.5 A, 250 VAC, 2.5 A, 30 VDC (Inductive); 3 A, 120 VAC, Tungsten (TV-3); 1/6HP, 120 VAC; 1/2HP, 250 VAC

Two-pole:

General purpose: 5 A, 250 VAC, 30 VDC (Resistive); 2 A, 250 VAC, 3 A, 30 VDC (Inductive); 3 A, 120 VAC, Tungsten (TV-3); 1/6HP, 120 VAC; 1/3HP, 240 VAC

High-sensitivity: 3 A, 250 VAC, 30 VDC (Resistive); 1 A, 250 VAC, 1.5 A, 30 VDC (Inductive)

Latching: 3 A, 250 VAC, 30 VDC (Resistive); 1.5 A, 250 VAC, 2 A, 30 VDC (Inductive); 3 A, 120 VAC, Tungsten (TV-3); 1/6HP, 120 VAC; 1/3HP, 250 VAC

Contact material AgCdO

Maximum operating voltage 380 VAC, 125 VDC

Maximum operating current

One-pole:

General purpose: 10 A
High-capacity: 16 A
High-sensitivity: 5 A
Latching: 5 A

Two-pole:

General purpose: 5A
High-sensitivity: 3A
Latching: 3A

Maximum switching capacity

One-pole:

General purpose, Resistive: Unsealed – 2,500 VA, 300 W; Sealed – 2,000 VA, 240 W
High-capacity, Resistive: Unsealed – 4,000 VA, 480 W
High-sensitivity, Resistive: Unsealed/Sealed – 1,250 VA, 150 W
Latching, Resistive – 1,250 VA, 150 W

Two-pole:

General purpose, Resistive: Unsealed – 1,250 VA, 150 W; Sealed –1,000 VA, 120 W
High-sensitivity, Resistive: Unsealed/Sealed – 750 VA, 90 W
Latching, Resistive – 750 VA, 90 W

Minimum permissible load

One-pole:
100 mA at 5 VDC

Two-pole:
10 mA at 5 VDC

Coil Data [% of rated voltage]

Pickup voltage 70% max. (DC & High-Sensitivity DC); 80% max. (AC)

Dropout voltage 15% min. (DC & High-Sensitivity DC); 30% min. (AC)

Set voltage 70% max.

Reset voltage 70% max.

Maximum voltage 110% at 70°C

Characteristic Data

Initial contact resistance

One-pole: 30mΩ max.
Two-pole: 50mΩ max.

Operate time 15ms max.

Release time

AC coil: 10ms max.
DC coil: 5ms max.

Set time – Latching 20ms max.

Reset time – Latching 20ms max.

Insulation resistance 1,000MΩ min. (at 500 VDC)

Dielectric strength

One-pole:

Between coil and contacts: 5,000 VAC, 50/60 Hz for 1 minute
Across open contacts of same pole: 1,000 VAC, 50/60 Hz for 1 minute

Two-pole:

Between coil and contacts: 5,000 VAC, 50/60 Hz for 1 minute
Between contact sets: 3,000 VAC, 50/60 Hz for 1 minute
Across open contacts of same pole: 1,000 VAC, 50/60 Hz for 1 minute

Latching:

Between set and reset coils: 1,000 VAC, 50/60 Hz for 1 minute

Ambient temperature -40° to 70°C

Service life

Mechanical:

AC coil: 10,000,000 operations min.
DC coil: 20,000,000 operations min.

Electrical: 100,000 operations min. for all resistive and inductive ratings with the following exceptions: *One-pole, General purpose, Sealed:* 8 A, 250 VAC, 30 VDC
Two-pole, General purpose, Sealed: 4 A, 250 VAC, 30 VDC

Construction Data

Termination Plug-in, Quick Connect, and PCB terminals

Construction Semi-sealed and Fully-sealed

Weight .6 oz (17 g), Latching, Quick Connect Type: .71 oz (20 g)

Packaging method Trays

Ordering Information

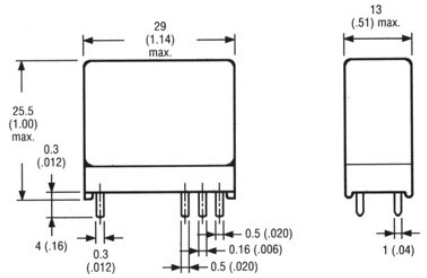
Part number	Rated voltage (V)	Coil res. (Ohms)	Power	Contact rating	Type
G2R-1 -DC5	5 DC	47	530mW	10 A	SPDT
-DC6	6 DC	68		10 A	PCB
-DC12	12 DC	275		10 A	General
-DC24	24 DC	1,100		10 A	Purpose
-DC48	48 DC	4,170	———	10 A	Semi-Sealed
-AC24	24 AC	260	0.9 VA	10 A	
-AC120	120 AC	6,500		10 A	
-AC240	240 AC	30,000		10 A	
G2R-14 -DC5	5 DC	47	530mW	10 A	SPDT
-DC6	6 DC	68		10 A	PCB
-DC9	9 DC	153		10 A	General
-DC12	12 DC	275		10 A	Purpose
-DC24	24 DC	1,100		10 A	Sealed
-DC48	48 DC	4,170	———	10 A	
-AC12	12 AC	65	0.9 VA	10 A	
-AC24	24 AC	260		10 A	
-AC120	120 AC	6,500		10 A	
-AC240	240 AC	30,000		10 A	
G2R-1-E -DC5	5 DC	47	530mW	16 A	SPDT
-DC12	12 DC	275		16 A	PCB
-DC24	24 DC	1,100		16 A	High-
-DC48	48 DC	4,170	———	16 A	Capacity
-AC24	24 AC	260	0.9 VA	16 A	Semi-Sealed
-AC120	120 AC	6,500		16 A	
G2R-14-H -DC5	5 DC	70	360mW	5 A	SPDT
-DC6	6 DC	100		5 A	PCB
-DC12	12 DC	400		5 A	High-
-DC24	24 DC	1,600		5 A	Sensitivity Sealed
G2R-1A -DC5	5 DC	47	530mW	10 A	SPST-NO
-DC6	6 DC	68		10 A	PCB
-DC12	12 DC	275		10 A	General
-DC24	24 DC	1,100		10 A	Purpose Semi-Sealed
G2R-1A4 -DC5	5 DC	47	530mW	10 A	SPST-NO
-DC12	12 DC	275		10 A	PCB
-DC24	24 DC	1,100	———	10 A	General
-AC24	24 AC	260	0.9 VA	10 A	Purpose
-AC120	120 AC	6,500		10 A	Sealed
G2R-1A-E -DC5	5 DC	47	530mW	16 A	SPST-NO
-DC12	12 DC	275		16 A	PCB
-DC24	24 DC	1,100		16 A	High- Capacity Semi-Sealed
G2R-1-S -DC5	5 DC	47	530mW	10 A	SPDT
-DC6	6 DC	68		10 A	Plug-in
-DC12	12 DC	275		10 A	General
-DC24	24 DC	1,100	———	10 A	Purpose
-AC12	12 AC	65		10 A	Unsealed
-AC24	24 AC	260	0.9 VA	10 A	
-AC120	120 AC	6,500		10 A	

Note: 1. Other coil voltages available. Consult Omron.

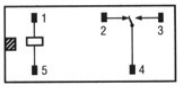
Part number	Rated voltage (V)	Coil res. (Ohms)	Power	Contact rating	Type
G2R-1-T -DC5	5 DC	47	530mW	10 A	SPDT
-DC12	12 DC	275		10 A	Quick
-DC24	24 DC	1,100	———	10 A	Connect
-AC24	24 AC	260	0.9 VA	10 A	Upper
-AC120	120 AC	6,500		10 A	Mounting Bracket Unsealed
G2R-2 -DC5	5 DC	47	530mW	5 A	DPDT
-DC12	12 DC	275		5 A	PCB
-DC24	24 DC	1,100	———	5 A	General
-AC24	24 AC	260	0.9 VA	5 A	Purpose
-AC120	120 AC	6,500		5 A	Semi-Sealed
G2R-24 -DC5	5 DC	47	530mW	5 A	DPDT
-DC6	6 DC	68		5 A	PCB
-DC12	12 DC	275		5 A	General
-DC24	24 DC	1,100		5 A	Purpose
-DC48	48 DC	4,170	———	5 A	Sealed
-AC24	24 AC	260	0.9 VA	5 A	
-AC120	120 AC	6,500		5 A	
G2R-24-H -DC5	5 DC	70	360mW	3 A	DPDT
-DC6	6 DC	100		3 A	PCB
-DC12	12 DC	400		3 A	High-
-DC24	24 DC	1,600		3 A	Sensitivity Sealed
G2R-2A4 -DC5	5 DC	47	530mW	5 A	DPST-NO
-DC12	12 DC	275		5 A	PCB
-DC24	24 DC	1,100	———	5 A	General
-AC24	24 AC	260	0.9 VA	5 A	Purpose
-AC120	120 AC	6,500			Sealed
G2R-2-S -DC5	5 DC	47	530mW	5 A	DPDT
-DC12	12 DC	275		5 A	Plug-in
-DC24	24 DC	1,100	———	5 A	General
-AC24	24 AC	260	0.9 VA	5 A	Purpose
-AC120	120 AC	6,500		5 A	Unsealed
G2RK-1 -DC5	5 DC	47	850mW	5 A	SPDT
-DC12	12 DC	275	(Set)	5 A	PCB
-DC24	24 DC	1,100	600mW (Reset)	5 A	Dual Coil Latching Semi-Sealed
G2RK-2 -DC5	5 DC	47	850mW	3 A	DPDT
-DC12	12 DC	275	(Set)	3 A	PCB
-DC24	24 DC	1,100	600mW (Reset)	3 A	Dual Coil Latching Semi-Sealed

Dimensions [Unit: mm (inch)]

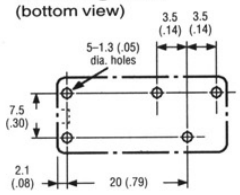
PCB Terminal: SPDT (General Purpose, High Sensitivity)



Terminal arrangement/ Internal connections (bottom view)

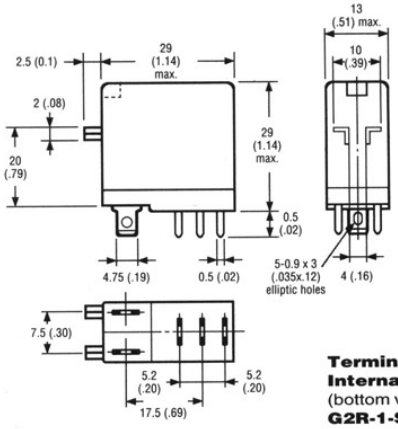


Mounting holes (bottom view)

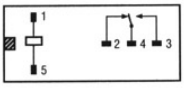


Note: 1. For SPST-NO, standard version, remove terminal no. 2.
2. ▬ and ┄┄ indicate mounting orientation marks.

Plug-in: SPDT

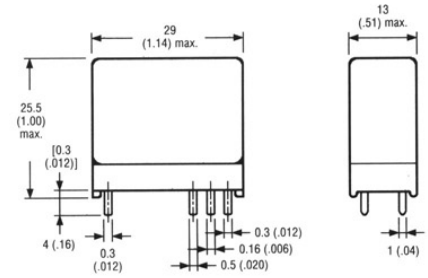


Terminal arrangement/ Internal connections (bottom view) **G2R-1-S**

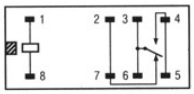


Note: 1. ▬ and ┄┄ indicate mounting orientation marks.

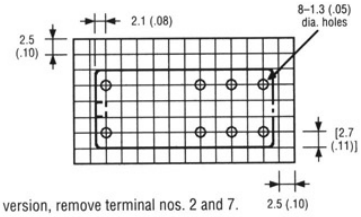
PCB: SPDT High Capacity



Terminal arrangement/ Internal connections (bottom view)

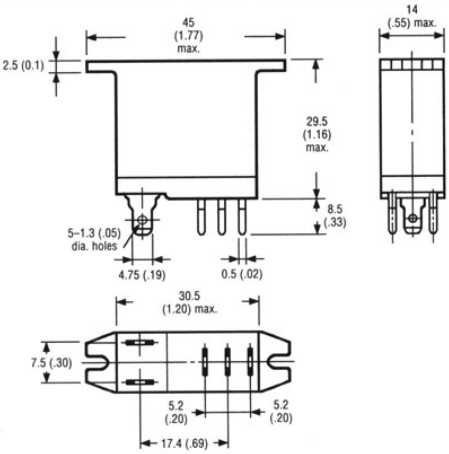


Mounting holes (bottom view)

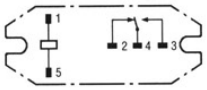


Note: 1. For SPST-NO, high-capacity version, remove terminal nos. 2 and 7.
2. ▬ and ┄┄ indicate mounting orientation marks.

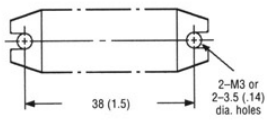
Quick Connect: SPDT



Terminal arrangement/ Internal connections (bottom view)



Mounting holes (bottom view)

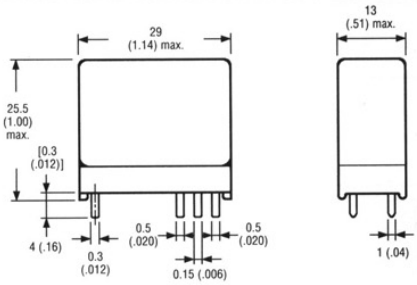


Note: 1. For SPST-NO, quick connect version, remove terminal no. 2.

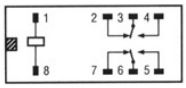
CAN'T FIND THE PRODUCT SOLUTION YOU NEED? MANY OTHER STYLES AND VARIATIONS ARE AVAILABLE. CALL YOUR OMRON REPRESENTATIVE FOR MORE INFORMATION.

Dimensions [Unit: mm (inch)]

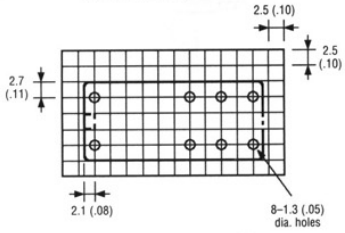
PCB Terminal: DPDT (General Purpose, High Sensitivity)



Terminal arrangement/ Internal connections (bottom view)

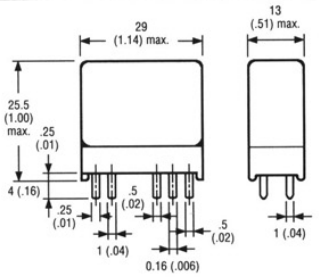


Mounting holes (bottom view)

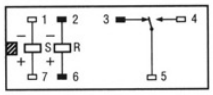


Note: 1. For DPST-NO, general purpose and high-sensitivity versions, remove terminal nos. 2 and 7.
2. ▬ and ┆ ┆ indicate mounting orientation marks.

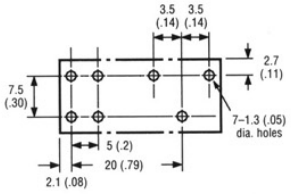
SPDT Dual Coil Latching



Terminal arrangement/ Internal connections (bottom view)

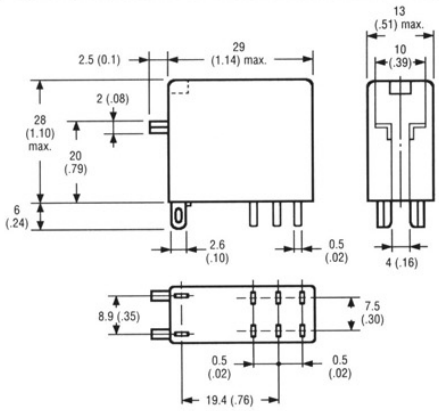


Mounting holes (bottom view)

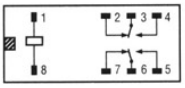


Note: 1. For SPST-NO, latching version, remove terminal no. 3.
2. ▬ and ┆ ┆ indicate mounting orientation marks.

Plug-In: DPDT

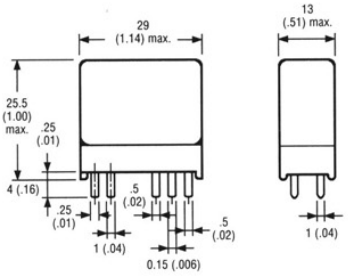


Terminal arrangement/ Internal connections G2R-2-S (bottom view)

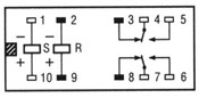


Note: 1. ▬ and ┆ ┆ indicate mounting orientation marks.

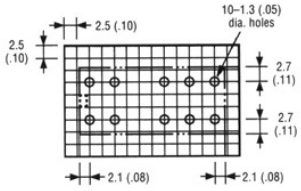
DPDT Dual Coil Latching



Terminal arrangement/ Internal connections G2R-2-S (bottom view)



Mounting holes (bottom view)



Note: 1. For DPST-NO, latching version, remove terminal nos. 3 and 8.
2. ▬ and ┆ ┆ indicate mounting orientation marks.

POTTER & BRUMFIELD

KUL series

5 AND 10 AMP MAGNETIC LATCHING RELAY

File E22575
File 15734

FEATURES

- Single or dual-wound DC coils or single-wound AC coils.
- Contact arrangements to 3PDT.
- Reset occurs by reversing polarity in a single coil relay or by energizing the reset winding in dual coil relays.
- Uses same sockets as other KU relays.
- Well suited for applications such as alarm systems, machine tools, battery chargers and process controls.

CONTACT DATA @ 25°C

Arrangements:
DC Single Coil: 1 Form C (SPDT), 2 Form C (DPDT) and 3 Form C (3PDT).
DC Dual Coil: 1 Form C (SPDT) and 2 Form C (DPDT).
AC Single Coil: 1 Form C (SPDT), 2 Form C (DPDT) and 3 Form C (3PDT).
Materials: Fine silver and siver-cadmium oxide.
Expected Life:
Mechanical: 10 million operations.
Electrical: 100,000 operations minimum at rated load.

CONTACT RATINGS

Contact Code	Arrangement	Ratings
1,3	1,2,3 poles	5A @ 28VDC or 240VAC, 80% PF; 1/10 HP @ 120VAC, 1/4 HP @ 240VAC
5,6,7	1,2,3 poles	10A @ 28VDC or 240VAC, 80% PF; 1/4 HP @ 120VAC, 1/3 HP @ 240VAC

INITIAL DIELECTRIC STRENGTH

Between Open Contacts: 500V rms.
Between Adjacent Contacts: 1,500V rms.
Between Contacts and Coil: 1,500V rms.

COIL DATA @ 25°C

Duty Cycle: Continuous. (Latch and reset not to be energized simultaneously).
Initial Insulation Resistance: 100 megohms, minimum.
Initial Breakdown Voltage: 1500V rms, 60 Hz. between all elements.

Note: On single coil AC models one terminal is common. Latch/Reset function is accomplished by input in series with a diode to provide the correct polarity to the coil. To perform either function, the terminal not being used (Latch or Reset) must be open or isolated with no other path to common or ground.

COIL DATA

	Nominal Voltage	DC Resistance in Ohms ± 10%†	Must Operate Voltage	0.5 W Resistor
DC Coils	**Single Coil**			
	6	32.1	4.5	—
	12	120	9.0	—
	24	472	18.0	—
	48	1,800	36.0	—
	110	10,000	82.5	—
	Dual Coil*			
	6	22	4.5	—
	12	90	9.0	—
	24	350	18.0	—
	48	1400	36.0	—
AC Coils 50/60 Hz.	**Single Coil with Diodes****			
	6	10.5	5.1	47Ω
	12	37	10.2	150Ω
	24	176	20.4	680Ω
	48	585	40.8	2,200Ω
	120	3,700	102.0	15,000Ω
	240	17,900	204.0	68,000Ω
	Dual Coil			
		Latch / Reset		
	24	100 / 250	20.4	—
	120	2525 / 7800	102.0	—

* Dual coil available only with 1 or 2 Form C contacts. On standard dual coil relays, the latch and unlatch voltage must be the same. For unlike voltages, please contact your sales representative.
** Diodes and resistors included inside relay with 1 and 2 Form C contacts. For 3 Form C relays, the customer must furnish and wire diodes and resistors externally.
† ±15% for AC coils.

OPERATE DATA @ 25°C

Must Operate Voltage:
DC Coils: 75% of nominal voltage.
AC Coils: 85% of nominal voltage.
Operate Time : 25 milliseconds maximum at nominal voltage.
Release or Reset Time: 25 milliseconds maximum at nominal voltage.

ENVIRONMENTAL DATA

Temperature Range:
Storage: -45°C to +105°C.
Operating:
Single Coil AC & DC: -45°C to +70°C.
Dual Coil DC: -45°C to +50°C.

MECHANICAL DATA

Termination: .187" (4.75 mm), .205" (5.21 mm) quick connect/solder or printed circuit terminals. Sockets are available for use with .187" (4.75 mm) terminals. (See page 86 & 87.)
Insulating Material: Molded phenolic.
Enclosure: Clear plastic polycarbonate heat and shock resistant case.
Weight: 3.4 oz. (96 g) approximately.

ORDERING INFORMATION

Typical Part No. ➤	KUL	-11	D	1	1	D	-12

1. BASIC SERIES:
KUL magnetic latching relay

2. CONTACT ARRANGEMENT:
5 = 1 Form C (SPDT)
11 = 2 Form C (DPDT)
14 = 3 Form C (3PDT)

3. COIL INPUT:
A = AC D = DC

4. MOUNTING:
1 = Plain case
2 = Plain case (Push-to-latch reset buttons)
5 = Bracket mount case
6 = Bracket mount case (Push-to-latch reset buttons)
9 = Stud on end of case

5. TERMINALS & CONTACT MATERIALS:
1 = .187" (4.75 mm) quick connect/solder; silver, 5 amps.
3 = Printed circuit terminal; silver, 5 amps.
5 = .187" (4.75 mm) quick connect/solder; silver-cadmium oxide, 10 amps.
6 = .205" (5.21 mm) quick connect/solder; silver-cadmium oxide, 10 amps.
7 = Printed circuit terminals; silver-cadmium oxide, 10 amps.

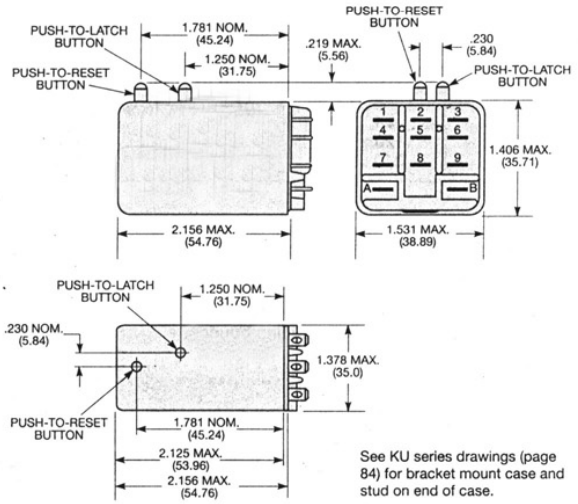
6. NUMBER OF COILS
S = Single coil D = Dual coil (1 & 2 pole models only)

7. COIL VOLTAGES:
Single coil—0-240VAC
0-110VDC
Dual coil—0-48VDC, 24 or 120VAC (to 2 Form C)

STOCK ITEMS – The following items are normally maintained in stock for immediate delivery.

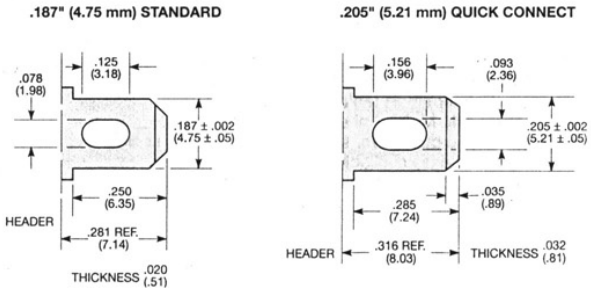
KUL-5A15S-120	KUL-11D11D-24	KUL-11D15S-12
KUL-11A15S-24	KUL-11D15D-12	KUL-11D15S-24
KUL-11A15S-120	KUL-11D15D-24	

OUTLINE DIMENSIONS

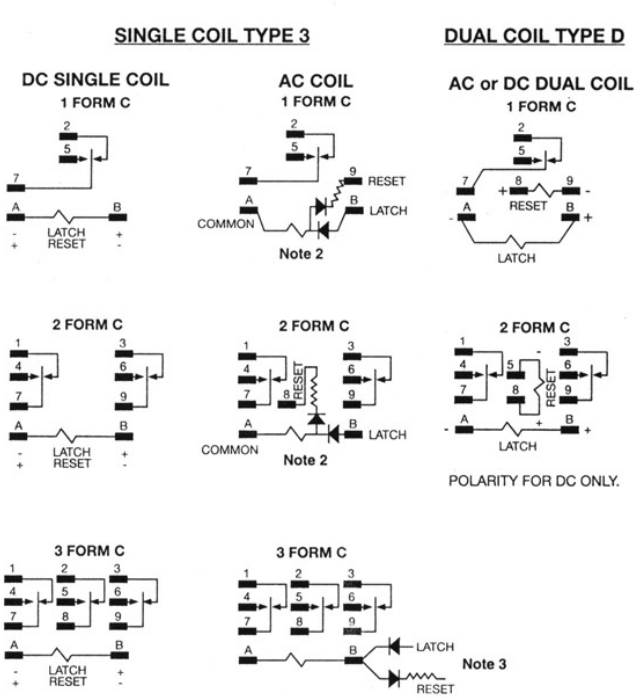


See KU series drawings (page 84) for bracket mount case and stud on end of case.

TERMINAL DIMENSIONS



WIRING DIAGRAMS (Bottom Views)

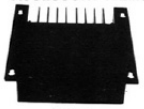


Note 1 Contact positions shown in diagrams is with the "RESET" input having been energized last.

Note 2 Do not connect any low impedance loads from terminal B to A.

Note 3 Resistor and diodes connected by customer. See Coil Data Chart on KUL Series engineering data page for resistor value. Recommended using 1N4007 diode.

ACCESSORY ITEMS FOR KBPB AVAILABLE FROM YOUR DISTRIBUTOR



Auxiliary Heatsink Part No. 9861

Knob/Dial Kit Part No. 9832

Potentiometer Kit Part No. 9831

SI-3 Isolator for S_1, S_2, S_3 Part No. 9447

LIMITED WARRANTY

For a period of 18 months from date of original purchase KB will repair or replace without charge devices which our examination proves to be defective in material or workmanship. This warranty is valid if the unit has not been tampered with by unauthorized persons, misused, abused, or improperly installed and has been used in accordance with the instructions and/or ratings supplied. The aforegoing is in lieu of any other warranty or guarantee expressed or implied, and we are not responsible for any expense (including installation and removal), inconvenience, or consequential damage, including injury to any person, caused by items of our manufacture or sale. Some states do not allow certain exclusions or limitations found in this warranty so that they may not apply to you. In any event, KB's total liability, under all circumstances, shall not exceed the full purchase price of this unit. (Rev. 10/84)

The information contained in this brochure is intended to be accurate. However, the manufacturer retains the right to make changes in design which may not be included herein.

KB ELECTRONICS, INC.
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Outside Florida Call TOLL FREE (800) 221-6570 •Email-info @ kbelectronics.com
www.kbelectronics.com

A40210A PC 2.5M 03/01

KBPB™ "Cycler" Solid State DC Motor Speed Controls

CE Improved—Contains c UL us KBMM* Speed Control and APRM*-2C for Faster Switching

Installation and Operating Instructions

KBPB®

KBPB® mounted on Auxiliary Heatsink

5K Remote Potentiometer

Knob and Dial Plate (Accessory Item Not Included)

- Ratings up to 1½ HP-120V & 3HP-240V
- Multiple Horsepower Capability with Plug-in Horsepower Resistor® (supplied separately)
- Voltage Following
- Contains the KB APRM (PATENTED) which provides Instant Anti-Plug Reversing and Solid State Dynamic Braking.
- Adjustable ACCEL and DECEL.
- Provision for AC Line and Armature fusing (fuses supplied separatley) *Patented

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See SAFETY WARNING on page 18.

PENTA KB POWER™

A COMPLETE LINE OF SCR DRIVES

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IMPORTANT

Read these simplified instructions before operating control. (SEE WARNING ON PAGE 18.)

1. Be sure input AC line voltage corresponds to control voltage. (See electrical rating chart page 4)
2. Install the correct Plug-in Horsepower Resistor® (supplied separately) according to input voltage and motor horsepower (see chart, page 5).
3. Recheck connections: AC line to L1 and L2; armature to A1 and A2 and Field (Shunt motors only) to F+ and F−. Connect ground via ground screw. (Note: If motor runs in improper direction, interchange armature leads)
4. Connect S1 to S2 or S2 to S3 to activate control. LED brake light will be "on" if no connection is made.
5. AC Line Fuse and Armature Fuse must be installed in this product. (supplied separately)—(see page 10, Table 6)
6. Nominal trimpot settings are as follows (expressed in % of full CW rotation):

TABLE 1: NOMINAL TRIMPOT SETTINGS—SPEED CONTROL MODULE

MIN (minimum speed):	15%	CL (current limit/torque):	65%	For detailed instructions see Sec. III
MAX (maximum speed):	65%	ACCEL (acceleration start):	20%	
IR (IR compensation):	25%	DECEL (deceleration):	20%	

FOR TECHNICAL ASSISTANCE CALL TOLL FREE (OUTSIDE NY STATE ONLY) 1-800-221-6570

PLUG-IN HORSEPOWER RESISTOR®

A Plug-in Horsepower Resistor® must be installed to match the control to the motor horsepower and voltage. See Table 4 for the correct value. Plug-in Horsepower Resistors® are stocked by your distributor (supplied separately).

TABLE 2. ELECTRICAL RATINGS

MODEL NUMBER	AC LINE VOLTAGE (VAC)**	MOTOR VOLTAGE (VDC)	RATING WITHOUT AUXILIARY HEATSINK			RATING WITH AUXILIARY HEATSINK		
			AC LOAD CURRENT (RMS AMPS)	DC LOAD CURRENT (AVG. AMPS)	MAX. HP	AC LOAD CURRENT (RMS AMPS)	DC LOAD CURRENT (AVG. AMPS)	MAX. HP
KBPB-125	120	90–130	12.0	8.0	¾	24.0	16.0	1½
KBPB-225	240	180	12.0	8.0	1½	24.0	16.0	3

TABLE 3. GENERAL PERFORMANCE SPECIFICATIONS

Speed range (ratio)	50:1	CL/torque range (% full load)	0–200
Load regulation—armature feedback (0-full load, 50:1 speed range) (% base speed)	1*	Accel time range (0-full speed) (secs.)	.2–10
		Decel time range (full-0 speed) (secs.)	.2–10
Load regulation—tachometer feedback (0-full load, 50:1 speed range) (% set speed)	1*	Min. speed trimpot range (% full speed)	0–30*
		Max. speed trimpot range (% full speed)	50–110*
Line voltage regulation—armature feedback (at full load, ±10% line variation (% base speed)	½*	IR compensation trimpot range (at specified full load) (volts)	0–24
		Maximum allowable ambient temperature at full rating (°C/°F)	45/113
Line voltage regulation—tachometer feedback (at full load, ±10% line variation (% set speed)	½*	Tachometer feedback input volts (per 1000 RPM) (VDC)	7/50
Control linearity (% speed vs. dial rotation)	2	Maximum number of starts/stops or reversals (operations/min.)	10**

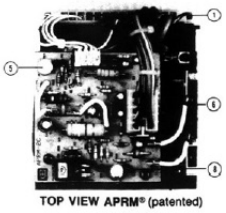
* Performance is for SCR rated PM motors only. Lower performance can be expected with other motor types. Factory setting is for 3% load regulation. To obtain superior regulation, see Sec. III F. Other factory trimpot settings are as follows: CL-150% FL, Accel-1 sec., Decel-1 sec., MIN-(0)-speed, MAX-full speed & IR-6 volts.

** Rating is based on a brake time of (1) second. For increased operations per minute or longer brake time, consult factory.

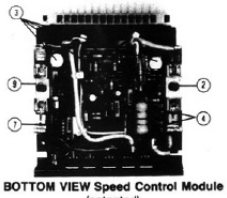
TABLE 4. PLUG-IN HORSEPOWER RESISTOR® CHART

MOTOR HORSEPOWER RANGE**		Plug-in Horsepower Resistor® Resistance Value (Ohms)	KB P/N
Armature Voltage 90–130V DC	Armature Voltage 180V DC		
1/100–1/50	1/50–1/25	1.0	9833
1/50–1/30	1/25–1/15	.51	9834
1/30–1/20	1/15–1/10	.35	9835
1/20–1/12	1/10–1/6	.25	9836
1/12–1/8	1/6–1/4	.18	9837
1/8–1/5	1/4–1/3	.1	9838
1/4	1/2	.05	9839
1/3	3/4	.035	9840
1/2	1	.025	9841
3/4	1–1/2	.015	9842
1***	2***	.01	9843
1–1/2***	3***	.006	9850

* Motor horsepower and armature voltage must be specified when ordering so that proper resistor will be supplied.
** For overlapping motor horsepower range use lower value Plug-in Horsepower Resistor.
*** Auxiliary heatsink must be used to achieve HP rating.



TOP VIEW APRM® (patented)



BOTTOM VIEW Speed Control Module (patented)

FIG. 1 FEATURES AND FUNCTIONS

(1) Barrier Terminal Block
(2) AC Line Fuse (supplied separately)
(3) Trimpots: Min, Max, CL, IR
(4) Trimpots: Accel, Decel
(5) Trimpot: Aux Speed
(6) Dynamic Brake Resistor
(7) Plug-in Horsepower Resistor® (supplied separately)
(8) "Brake" LED
(9) Armature Fuse (supplied separately)

INTRODUCTION

The KBPB® Full Wave Solid State DC Motor Speed and Reversing Control represents the latest state-of-the-art design achievable through modern technology.

Features Include:

- ***Integrated Circuitry***
  Used to control and amplify command and reference levels with both closed and open loop feedback to provide superior motor regulation. (Speed changes due to load, line voltage, or temperature variations are held to mininum levels.)
- ***High Quality Components***
  Selected and tested for proven dependability.
- ***Transient Protection***
  Used to prevent failure of the power bridge circuit caused by voltage spikes on the AC line.
- ***High Reliability***
  When used in accordance with the instructions included in this manual, the KBPB® will provide years of trouble-free operation.

SECTION I. APPLICATION INFORMATION

A. *Motor Type.* The KBPB® is designed for Permanent Magnet (PM) and Shunt Wound D.C. motors. Controls operated on 120 volt AC inputs are designed for 90 volt SCR rated motors. Controls operated on 240 volt AC inputs are designed for 180 volt SCR rated motors. Use of higher voltage motors will result in degradation of full speed performance. Also, if motor is not an SCR rated type, the actual AC line amperage at full load should not exceed the motor's DC nameplate rating.

B. *Torque Requirements.* When replacing an AC induction motor with a DC motor and speed control, consideration must be given to the maximum torque requirements. The full load torque rating of the DC motor must be equal to, or greater than, that of the AC motor.

C. *Acceleration Start.* The KBPB® contains an adjustable acceleration start feature which allows the motor to smoothly accelerate from 0-full speed over a time period of .2–10 seconds. The "ACCEL" is factory set at 1 second.

D. *Limitations in Use.* The KBPB® controls are designed for use on machine applications.

E. *Switching Applications:* KBPB® contains the KB APRM® which is designed to provide anti-plug instant reverse, solid state dynamic brake and rapid cycling. The maximum recommended number of run-brake cycles is 10 per minute. If higher rates are required, contact our sales dept.

CAUTION: Consult factory before using on constant horsepower applications such as saws or drill presses. Do not use in explosive atmosphere.

CAUTION: Be sure the KBPB® is used within its max. ratings. Follow all installation instructions carefully. (Refer to Section II.)

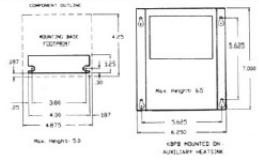
SECTION II. INSTALLATION INSTRUCTIONS

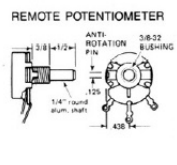
A. *Location and Mounting.* The KBPB control should be mounted on a flat surface and located in an area where it will not be exposed to contaminants such as water, metal chips, solvents or excessive vibration.

When mounting in an enclosure the air space should be large enough to provide adequate heat dissipation. The maximum allowable ambient temperature at full rating is 45°C/113°F. Consult factory if more information is required.

* Warning: Do not mount control with terminal block legend facing down. (Relay Plunger down.)

FIG. 2 MECHANICAL SPECIFICATIONS (inches)





B. *Initial Setup and Wiring*

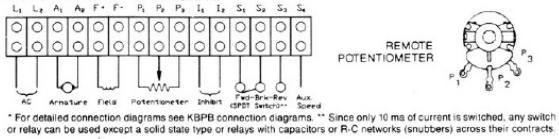
1. Install proper size Plug-in Horsepower Resistor® . (See chart page 5—table 4)
2. The KBPB℠ can be connected to a standard 120V or 240V 50/60 Hz AC line [Be sure the AC input voltage corresponds to the control voltage rating and the motor rating (e.g. 90–130VDC motor on 120VAC and 180VDC motor on 240VAC)].
3. Follow the recommended supply wire sizes as per Table 5.
4. Follow the NEC and other electrical codes that apply. CAUTION: Separate branch protection must be provided on 240V circuits. (Do not fuse neutral or grounded conductors.)
5. Connect control according to connection diagram—See Fig. 3.

TABLE 5. MINIMUM SUPPLY WIRE SIZE REQUIREMENTS

MAX. MOTOR AMPS (DC AMPS)	MAX. MOTOR HP 90V	MAX. MOTOR HP 180V	MINIMUM WIRE SIZE (AWG) Cu Only	
			MAX. 50 FOOT RUN	MAX. 100 FOOT RUN
6.0	1/2	1	16	14
12.0	1	2	14	12*
16.0	1/1/2	3	12	12

* Maximum recommended wire size.

FIG. 3 CONNECTION DIAGRAM



* For detailed connection diagrams see KBPB connection diagrams. ** Since only 10 ma of current is switched, any switch or relay can be used except a solid state type or relays with capacitors or R-C networks (snubbers) across their contacts.

TABLE 6. ARMATURE FUSE CHART

90VDC MOTOR	180VDC MOTOR	APPROX. DC MOTOR CURRENT (AMPS)	FUSE RATING (AC AMPS)
HORSEPOWER			
1/30	1/15	.33	1/2
1/20	1/10	.5	3/4
1/15	1/8	.65	1
1/12	1/6	.85	1-1/4
1/8	1/4	1.3	2
1/6	1/3	1.7	2-1/2
1/4	1/2	2.5	4
1/3	3/4	3.3	5
1/2	1	5.0	8
3/4	1-1/2	7.5	12*
1	2	10.0	15
1-1/2	3	15.0	25*

* Also used as AC Line Fuse.

NOTES:

1. AC Line Fuse is chosen according to the maximum rating of the control:
   12 Amp fuse for all motors up to ¾ HP-90V and 1½ HP-180VDC.
   25 Amp fuse for all motors 1 and 1½ HP-90V and 2 and 3 HP-180VDC.
   (Use Buss ABC, Litt. 326 ceramic fuse or equivalent.)
2. *Armature Fuse* can be chosen in accordance with the fuse chart. Note: The armature fuse is calculated based on the approximate full load DC current rating of the motor times a form factor of 1.5. If motor has characteristics not consistent with these approximations, a different fuse value may have to be used. Fuses are available from your distributor. Also available is a Fuse Kit (KB Part #9870) containing 700 assorted fuses.

A. *Acceleration Start.* The ACCEL is factory set at approx. 1 second. To readjust to different times, set the knob to the desired position as indicated in Fig. 4.

B. *Deceleration.* The DECEL is factory set to provide minimum ramp-down time. To increase the ramp-down time adjust the DECEL trimpot as indicated in Fig. 4.

C. *Maximum Speed Adjustment.* Turn Speed Control Knob to full speed (maximum CW position). Adjust max. speed trimpot to new desired setting.

NOTE: Do not attempt to adjust the max. speed above the rated motor RPM since unstable motor operation may occur. For moderate changes in the max. speed, there will be a slight effect on the min. speed setting when the min. speed is set at zero. There may be a significant variation in the min. speed setting if the min. speed is at a higher than zero setting.

D. *Minimum Speed Adjustment.* If a higher than zero minimum speed is desired, readjust the minimum speed by turning the speed control knob to zero setting (full CCW position). Then adjust the min. speed trimpot to the desired setting.

NOTE: The min. speed adjustment will affect the max. speed setting. Therefore, it is necessary to readjust the max. speed after the min. speed, and it may be necessary to repeat the sequence until both the min. and max. speeds are set to desired levels.

E. *Current Limit (CL/Torque Adjustment).* CL circuitry is provided to protect the motor and control against overloads and demagnetization of PM motors. The CL also limits the inrush current to a safe level during startup. The CL is factory set to approximately 1.5 times the full load rating of the motor. (CL trimpot is nominally set to approx. 65% of full CW rotation.)

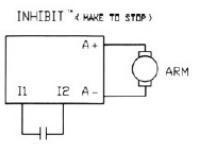
NOTE: The correct value Plug-in Horsepower Resistor® must be installed in order for the CL and IR comp. to operate properly.

To set the CL to factory specifications adjust as follows:

1. Set speed control knob at approximately 30–50% CW rotation. Set CL trimpot to full CCW position.
2. Connect a DC ammeter in series with the armature lead.

Jog or Run speed, either in Forward or Reverse direction. (DECEL Trimpot does not affect the brake time.)

In order for the KBPB control to drive a motor, S_1 and S_2 must be connected together for Forward and S_2 and S_3 must be connected together for Reverse. If no connection is made to S_2, the control will be in a "Brake" mode. The brake circuit consists of an SCR and dynamic brake resistor (RB). An LED indicator on the APRM® shows that power is applied to the SCR gate. If braking is not required, the wire to RB may be disconnected. (Note that the LED will still light with RB disconnected.)



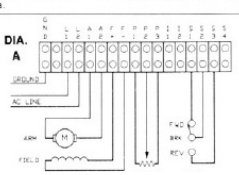
INHIBIT℠: Terminals I_1 and I_2 provide an Inhibit℠ function which electronically extinguishes the output of the control. This circuit is activated by connecting the I_1 and I_2 terminals together. When installing the KBPB be sure to follow the mounting and wiring instructions found in Sec. II.

NOTE: When switching terminals S_1, S_2, S_3, approximately 10ma of current with full motor voltage may be present. Other terminals (I_1, I_2, P_1, P_2, P_3 and S_4) are low voltage to each other, but line voltage to ground. Any switch or relay can be used for switching **except** solid state relays or contacts with R-C networks (snubbers). S_1 and S_2 must be opened before S_2 and S_3 are closed and vice versa.

The following wiring diagrams are presented to demonstrate the capabilities of the KBPB.

A. **Forward-Brake-Reverse with Single Potentiometer.** Use an SPDT ON-OFF-ON switch. Close S_1 and S_2 for motor to run in FWD direction. Open S_2 for Brake. Close S_2 and S_3 for motor to run in Reverse direction. If Brake position is not required, an SPDT (non-center OFF) may be used. This provides instant Anti-plug Reversing.

DIA. A



CAUTION: If control is wired to a transformer, it is advisable to switch the secondary to disconnect power. If the primary is switched, additional snubber capacitors may have to be added across the transformer output to prevent damage to the power bridge.

CAUTION: Do not bundle control wires P_1, P_2, P_3, I_1, I_2, S_1–S_4 with line or motor leads. If wires are over 18", use shielded cables.

C. Voltage Following. All models can be controlled with an **isolated** analog reference voltage (0–9VDC) in lieu of the main speed potentiometer. The voltage is connected to P_2(+) and F−. The control output voltage will linearily follow the input voltage. The source impedance of the input should be 10K ohms or less. The Min trimpot can be used to provide an offset speed. If an offset is not required adjust the Min to 0+ or 0− speed as desired. The Max trimpot is rendered inoperative in the voltage following mode. Use auxiliary trimpot to limit the control range. If the input signal is not isolated, or is a current signal (4–20ma), the KBSI-240D Signal Isolator must be used. It will allow direct connection to process controllers and microprocessors.

CAUTION: 1. The voltage feeding P_2 and F− must be isolated from the AC line. Do not ground P_2 or F− to set up a zero or ground reference.
2. Do not bundle signal wires to P_2 and F− with AC line or motor connections. If signal wires are over 18", use shielded cables.

D. Fusing. The KBPB℠ has provision for a built-in AC line fuse and armature fuse. The AC line fuse protects the control against catastrophic failure. If the fuse blows, the control is miswired, the motor is shorted or grounded, or the KBPB℠ control is defective. The armature fuse provides overload protection for the motor and control. Choose the proper size armature fuse by multiplying the maximum **dc motor amps by 1.7. NOTE: Be sure to fuse each ungrounded AC line supply conductor. Do not fuse neutral or grounded conductors. All fuses should be normal blow** ceramic **3AG, ABC or equivalent.** (See Table 6 on page 10)

SECTION III—ADJUSTMENTS AND CONTROL FUNCTIONS—See Safety Warning Page 18

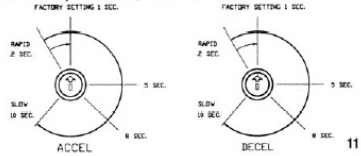
The KBPB has been factory adjusted to provide 0-full speed using the speed control knob. Minimum and Maximum speed trimpots are provided to change the speed from other than 0-full speed. The Acceleration (ACCEL) trimpot is provided to allow for a smooth start over an adjustable time period each time the AC power is applied or the speed pot is rotated. The DECEL trimpot controls the amount of ramp-down time when the speed pot is adjusted to a lower speed. **Note:** If P_2 is connected to P_1, or the enable lead, P_3, is opened, the control will ramp down to the MIN speed trimpot, setting. If I_1 is shorted to I_2, the control will coast down to zero speed. The Current Limit (CL, or torque output) adjustment is factory set to approximately 1½ times the motor rating. The IR Compensation (IR) is factory adjusted to provide excellent motor regulation under normal operation. The KBPB contains the KB APRM® which provides anti-plug "instant" reverse and solid state dynamic braking. The APRM® contains a trimpot which is used to preset a fixed speed for either the forward or reverse direction (see KBPB connection diagrams for additional information).

NOTE: In order for the IR comp and CL trimpot settings to be correct, the proper Plug-in Horsepower Resistor® must be installed for the particular motor and input voltage being used. Do not attempt to change the settings of the trimpots unless absolutely necessary since they are factory adjusted to near optimum settings.

The following procedure, presented in order of adjustment sequence, should be used when readjusting all trimpot functions:

Fig. 4 ACCEL/DECEL TRIMPOT ADJUSTMENT

CAUTION!
[PM motors only]. Adjusting the accel time below .5 seconds increases inrush current. It may be necessary to measure the peak inrush current and consult with motor manufacturer since field magnet demagnetization may occur.



3. Lock shaft of motor (be sure CL pot is in full CCW position). Apply power and rotate CL pot CW slowly until DC ammeter reads 1.5 times motor rating (do not exceed 2 times motor rating).

NOTE: If only an AC ammeter is available, it can be installed in series with AC input line. Follow above instructions; however, set AC amperage at .75 times motor rating.

F. *IR Compensation Adjustment.* IR compensation is provided to substantially improve load regulation. If the load presented to the motor does not vary substantially, the IR adjustment may be set at a minimum level (approximately ¼ of full setting). The control is factory adjusted to approximately 3% regulation. If superior performance is desired (less than 1% speed change of base speed from 0 to full load), then the IR comp. should be adjusted as follows:

NOTE: Excessive IR comp. will cause control to become unstable, which causes motor cogging.

1. Set IR comp. trimpot at approximately 25% of CW roation. Run motor unloaded at approximately ½ speed and record RPM.
2. Run motor with maximum load and adjust IR comp. trimpot so that the motor speed under load equals the unloaded speed per step 1.
3. Remove load and recheck unloaded RPM. If unloaded RPM has shifted, repeat procedure for more exact regulation.

The KBPB is now compensated to provide minimal speed change under large variations of applied load.

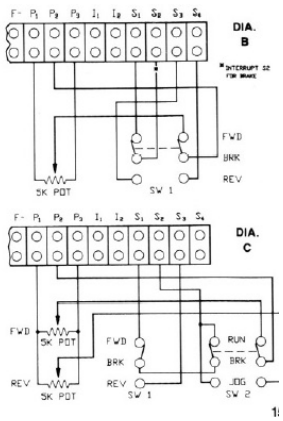
SECTION IV. KBPB APPLICATION INFORMATION

The KBPB is designed to offer a variety of switching functions. The APRM® module is the interface between command signals and the KBMM speed control module. By using terminals S_1, S_2 and S_3 the KBPB can be made to perform the following functions: Run-Brake, Forward-Brake-Reverse and Forward-Reverse (instant anti-plug reverse). Terminal S_4 is used to supply a control voltage which is adjustable with the APRM® trimpot R11. This voltage is used to preset a

B. **Forward-Brake-Reverse with Adjustable Reverse Speed.** Reverse speed is adjustable with the trimpot on the APRM® board. Use a DPDT ON-OFF-ON switch. In the Forward direction, the remote speed pot is used. In the Reverse direction, P_2 is connected to S_4 for speed adjustment. If Brake position is not required, a DPDT switch (non-center OFF) may be used. If, while in Forward or Reverse position, a separate Brake function is required, S_2 may be interrupted using a limit switch or relay. (For remote reverse speed pot adjustment, see Wiring Diagram C.)

C. **Forward-Brake-Reverse with Run-Brake-Jog.** Jog speed is adjusted with remote speed pot. For SW1 use an SPDT ON-OFF-ON switch. For SW2 use DPDT ON-OFF-ON with momentary return from Jog position. (For non-remote Jog speed use trimpot on APRM® , see Wiring Diagram B).

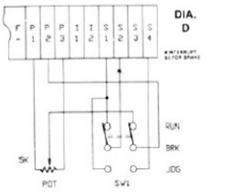
D. **Run-Brake-Jog with Adjustable Jog Speed.** The Jog speed is adjustable with the trimpot on the APRM® board. Use a DPDT ON-OFF-ON switch. In the Run mode, the external 5K speed pot is used. In the Jog mode P_2 is connected to S_4 and the Jog pot, located on the APRM® , is used for speed adjustment. If Brake position is not required, a DPDT switch (non-center OFF) may be used. If, while in Forward or Jog position,

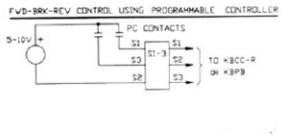


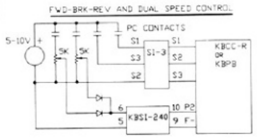
a separate Brake function is required, S_2 may be interrupted using a limit switch or relay. (For remote reverse speed pot adjustment, see Wiring Diagram C.)

E. **Isolated Input for S_1, S_2, S_3.** An isolator board SI-3 is available as an accessory. It allows the KBPB forward-brake-reverse function to be activated by an analog signal. The SI-3 installs by removing the 4-pin connector on the APRM. Install the SI-3 on the 4-pin header and plug the mating connector into the SI-3.

The SI-3 is activated by applying an analog voltage of 5–10VDC to terminals S_1, S_2 for forward, or S_3, S_2 for reverse. The KBPB with the SI-3 option is suitable for operation with programmable controllers. For complete isolation of the voltage following input Model KBSI-240 Signal Isolator should also be used.







F. **Tachometer feedback** (DC tachs only). The load regulation of the control can be improved to 1% of set speed over a 50:1 speed range by use of tachometer feedback. Since no provision is made for the tach input on the terminal block, the tach positive connection must be made directly to the B or T terminal on the speed control module. NOTE: If control is used on a reversing application, the tach wires must also be reversed so that positive (+) is always connected to B or T. To set control for tachometer feedback:

(1) For tach feedback, cut jumper J1 on Printed Circuit Board.
(Note: On Model KBPB-225, J1 is an 82K resistor)

(2) Connect tach as follows:

(a) 7 volts/1000 RPM Connect (+) lead to Terminal "T"
Connect (–) lead to Terminal I_2 or F–

(b) 50 volts/1000 RPM Connect (+) lead to Terminal "B"
Connect (–) lead to Terminal I_2 or F–

Note: Set IR Comp to minimum for tach feedback.

Note: The tachometer voltage input is based on 1,800 RPM motors. For motors other than 1,800 RPM, or for tachometer voltages other than what is specified, an external tachometer resistor must be used. Install the resistor (R_T) in series with positive (+) tachometer lead and the 7V input on the control. The value of R_T may be calculated using the following formula.

$R_T = [1.26 \times V_T \times S - 15{,}900]$

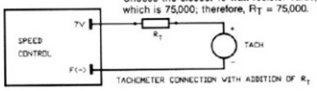
V_T = Tachometer voltage in volts/1,000 RPM

S = Base speed of motor in RPM

Example: Suppose you have a 3,600 RPM motor with a 20 volt/1,000 RPM tachometer:

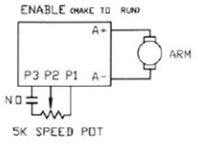
$R_T = 1.26 \times 20 \times 3{,}600 - 15{,}900 = 74{,}820$

Choose the closest ½ watt resistor value, which is 75,000; therefore, $R_T = 75{,}000$.



G. **Enable.** Control can be made to start and stop electronically with Enable. This circuit is "make to run" which is opposite of Inhibit.

Stop time is adjustable with DECEL trimpot. To obtain 0 speed when Enable is open MIN speed trimpot must be set to 0 speed. Two-speed operation can be obtained by setting the MIN speed to the desired level.

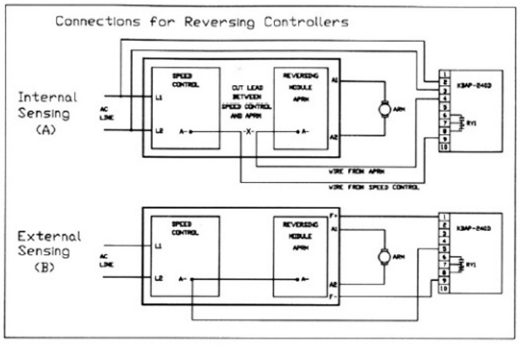


SAFETY WARNING—PLEASE READ CAREFULLY

This product should be serviced by a qualified technician, electrician or electrical maintenance personnel familiar with its operation and the hazards involved. Proper installation (see instruction information which accompanies product), which includes wiring, mounting in proper enclosure, fusing or other overcurrent protection and grounding, can reduce the chance of electric shocks, fires or explosion in this product or products used with this product, such as electric motors, switches, coils, solenoids and/or relays. Eye protection must be worn when working with control under power. This product is constructed of materials (plastics, metals, carbon, silicon, etc.) which may be a potential hazard. Individual material safety data sheets (MSDS) are available upon request. Proper shielding, grounding and filtering of this product can reduce the emission of radio frequency interference (RFI) which may adversely affect sensitive electronic equipment. If information is required on this product, contact our factory. It is the responsibility of the equipment manufacturer and individual installer to supply this safety warning to the ultimate user of this product. (SW effective 3/88).

H. **Overload Protection** The KBAP-240D is a multipurpose DC Current Sensing Relay and Overload Protector. It is specifically designed for use with DC motors and speed controls from 1/8–3 HP. The unit can be used with larger or smaller motors by utilizing the external method of connection. KBAP–240D operates by sensing current in the armature circuit. When the preset level is reached, an output relay trips. An adjustable time delay (.2–15 secs.) is incorporated, which eliminates nuisance tripping. Manual or automatic reset is provided at the user's option along with an LED, which indicates when the preset current level has been reached. In addition, a Hysteresis trimpot is provided which can be used to increase the differential between the pull-in and drop-out points of the output relay. When an overload occurs, the KBAP–240D can be used to shut the system down, sound an alarm, or initiate corrective action before damage occurs. The unit can be operated on either 120 or 240 VAC line voltage, and has five preset current trip points (2.5/5/10/15/20), which can be further adjusted with a built-in trimpot. See page 20 for connection diagram.

REVERSING APPLICATIONS. The KBAP set for Internal Sensing is suitable for unidirectional current only. Therefore, reversing controllers utilizing relays or reversing modules *cannot* be connected directly to the KBAP. For these applications the KBAP must be connected between the speed control and reversing module. For external Sensing the KBAP can be connected directly to the reversing control. See Fig. for correct connection diagrams (used for KB Models KBPB and KBCC-R suffix). See page 20 for connection diagram.

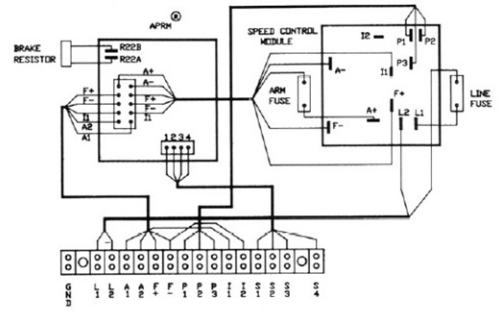


SECTION V. TROUBLESHOOTING GUIDE

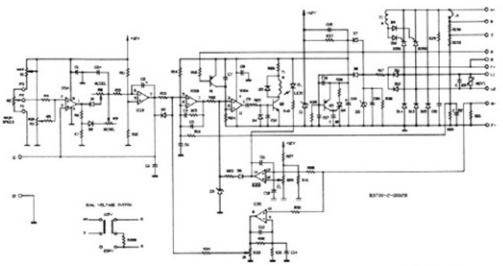
The following Troubleshooting Guide is intended for use by a qualified technician. The Guide is designed to isolate common malfunctions of the KBPB and/or motor. It should be used with the parts lists and schematics contained in this manual.

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
1. Motor does not run.	1. AC voltage not brought to L1, L2 terminals.	1. Correct wiring to control.
	2. Blown line or armature fuse.	2. Replace blown fuse with properly rated 3AB-type. If fuse blew due to miswiring, speed control module may be defective.
	3. Speed control knob set to 0.	3. Turn knob CW to start motor.
	4. Defective motor.	4. Check for defective motor, worn brushes, etc. Replace motor.
	5. Plug in Horsepower Resistor not installed.	5. Install proper size Plug-in Horsepower Resistor.
2. Motor hums, or runs at very low speed (with control knob set at high number) or motor slows down substantially when load is applied.	1. Low voltage.	1. Check line voltage at control and rewire as required.
	2. Overload condition: control in current limit mode (CL) (trimpot not set correctly).	2. Reduce loading; CL trimpot setting may have to be increased. See Section IV.
	3. Plug-in Horsepower Resistor not correct size.	3. Install proper size resistor.
	4. Incorrect wiring. Armature and shunt connections interchanged (shunt motor only).	4. Correct wiring (armature has lower resistance than field).
3. Erratic motor performance.	1. Defective motor, worn brushes etc.	1. Repair motor.
	2. Overload condition.	2. Remove overload.
	3. Plug-in Horsepower Resistor wrong size.	3. Replace with proper size.
	4. IR comp and/or CL trimpots not set properly.	4. Readjust trimpots as per Section IV.
	5. Defective speed control module.	5. Replace module.
4. Motor continues to run when speed control knob is set to 0.	1. Min speed trimpot not set to full CCW position.	1. Readjust min. trimpot.
	2. IR comp trimpot set too high.	2. Lower IR comp trimpot setting.
5. Motor will not run in either forward or reverse direction.	1. Incorrect wiring or faulty reversing switch.	1. Correct wiring. See KBPB connection diagrams.
	2. Defective APRM*	2. Replace APRM*
6. No Braking action in brake mode.	1. Incorrect wiring.	1. Correct wiring.
	2. Defective brake resistor.	2. Replace resistor.
	3. Defective APRM*	3. Replace APRM*
7. Motor runs in wrong direction.	1. Armature leads reversed.	1. Reconnect armature leads.

FIG. 5 INTERNAL CONNECTION DIAGRAM

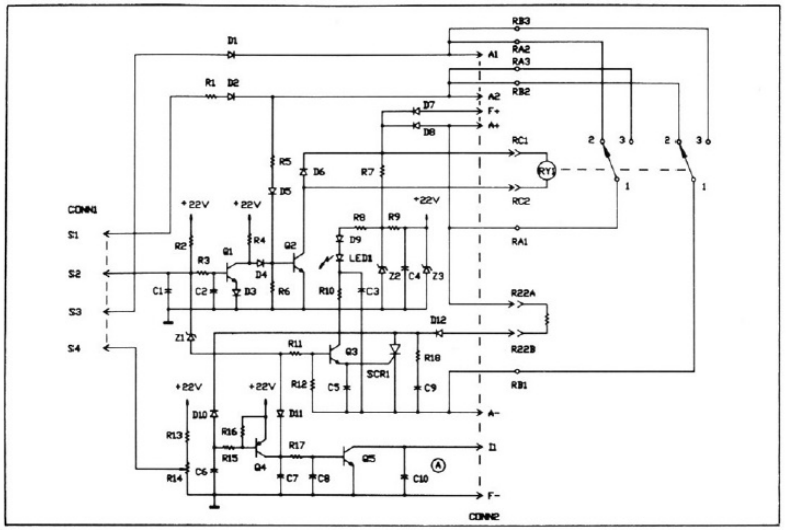


SECTION VI. (B) SPEED CONTROL MODULE SCHEMATIC*



* Patented.

SECTION IV. (C) APRM® SCHEMATIC—(patented)



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SEC. VI. (D) 120V SPEED CONTROL MODULE PARTS LIST

CKT. REF.	VALUE/RATING	MFG. TYPE	FUNCTION
C1	0.01ufd-25V	Ceramic Tubular	Capacitor
C14-16,18	0.01ufd-25V	Ceramic Tubular	Capacitor
C2	1.5ufd-50V	Electrolytic	Capacitor
C3	0.47ufd-50V	Film/lytic	Capacitor
C4	0.33ufd-50V	Metal Film	Capacitor
C5	0.033ufd-50V	Metal Film	Capacitor
C6,8,10,12,24	0.022ufd-25V	Ceramic Tubular	Capacitor
C7	0.1ufd-50V	Metal Film	Capacitor
C9,11,13	0.01ufd-50V	Metal Film	Capacitor
C17	4.7ufd-35V	Electrolytic	Capacitor
C19	100-0ufd-35V	Electrolytic	Capacitor
C20	0.047ufd-50V	Metal Film	Capacitor
C21,23	.1ufd-250VDC	Metal Film	Capacitor
C22	0.022ufd-50V	Metal Film	Capacitor
D1-D10	1A-600V	1N4005GP	Diode
D11,12	1.5A-600V	1N5397GP	Diode
D13, D14	25A-600V	D6025L	Power Diode
D15	15A-600V	D6015L	Power Diode
IC1		LM358P	Dual Op-Amp
IC2		LM324	Quad Op-Amp
J1	22 AWG		Jumper
LED1	35MA-30mcd	MV5753	CL Indicator
MOV1	150V	V150LA10A	Transient Suppressor
Q1,3	0.6A-40V	2N4403	Small Signal Transistor
Q2	0.6A-40V	2N4401	Small Signal Transistor
Q4	0.8A-50V	S347S101E	Small Signal SCR
R1*	10K-0.33W-10%	PTC-10YV	Max Trimpot
R2	5K-5W-20%		Main Speed Pot
R3	25K-0.33W-10%	PTC-10YV	Min Trimpot
R4	33K-0.25W-5%	Carbon Film	Resistor
R5,16,18,27	47K-0.25W-5%	Carbon Film	Resistor
R28,30,31	47K-0.25W-5%	Carbon Film	Resistor
R6	24K-0.25W-5%	Carbon Film	Resistor
R7,12	3.3K-0.25W-5%	Carbon Film	Resistor
R8	500K-0.33W-10%	PTC-10YV	Accel Trimpot
R9	500K-0.33W-10%	PTC-10YV	Decel Trimpot
R10,41	1K-0.25W-5%	Carbon Film	Resistor

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SEC. VI.(D) 120V SPEED CONTROL MODULE PARTS LIST

CKT. REF.	VALUE/RATING	MFG. TYPE	FUNCTION
R11	56K-0.25W-5%	Carbon Film	Resistor
R13,23,35	22K-0.25W-5%	Carbon Film	Resistor
R14,32	2.2M-0.25W-5%	Carbon Film	Resistor
R15	1M-0.25W-5%	Carbon Film	Resistor
R17	4.7K-3W-5%	MO-3	Resistor
R19A	62K-0.25W-5%	Carbon Film	Resistor
R19B	12K-0.25W-5%	Carbon Film	Resistor
R20	3.9K-0.25W-5%	Carbon Film	Resistor
R21*	0.006 ohm-1.0 ohm-5W-5%	Wire Wound	Plug-in-Horsepower Res.
R22,24,34	100K-0.25W-5%	Carbon Film	Resistor
R25	3.3K-0.25W-5%	Carbon Film	Resistor
R26	47 ohm-0.25W-5%	Carbon Film	Resistor
R29	25K-0.33W-10%	PTC-10YV	CL Trimpot
R33	10K-0.33W-10%	PTC-10YV	IR Trimpot
R36	1.0 ohm-0.25W-5%	Carbon Comp.	Resistor
R37	1.8K-0.25W-5%	Carbon Film	Resistor
R38	6.8K-0.25W-5%	Carbon Film	Resistor
R39	1K-0.25W-5%	Flameproof	Resistor
R40	4.7K-0.25W-5%	Carbon Film	Resistor
SCR1,2	25A-600V	S6025L	Power SCR
T1	1:1	KB Standard	Pulse Transformer
Z1	12V-1W-5%	1N4724A	Zener Diode
Z2	22V-1W-5%	IN4748A	Zener Diode
Z3	18V-1W-5%	1N4746A	Zener Diode
CHANGES FOR 240V SPEED CONTROL MODULE			
C21	.047ufd-400VDC	Metal Film	Capacitor
C23	.047ufd-250VAC/630VDC	Rita or Wima	Capacitor
J1	82K-0.25W-5%	Carbon Film	Resistor
MOV1	275V	V275LA20A	Transient Suppressor
R17	12K-7W-5% *	CW-7	Resistor
R19A	62K-0.25W-5%	Carbon Film	Resistor

* Components whose value/rating may vary with application.

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SEC. VII. APRM-2C–120V PARTS LIST

CKT. REF.	VALUE/RATING	MFG. TYPE	FUNCTION
C1, 11	0.01MF-50V-20%	Ceramic Disc	Capacitor
C2, 5, 6	0.01MF-50V-20%	Ceramic Axial	Capacitor
C3	10.0MF-100V-20%	Electrolytic	Capacitor
C4	15.0MF-35V-20%	Electrolytic	Capacitor
C8, 10	0.47MF-50V-20%	Electrolytic	Capacitor
C9	0.1MF-250V-20%	Mylar	Capacitor
D1-11	1A-600PIV	1N4005GP	Diode
D12	5A-500PIV	A15E	Diode
LED1	35mA-30mcd	MV5753	Brake Indicator
Q1, 5	600mADC-40VDC	2N4401	Bipolar Transistor
Q2, 3	300mADC-350VDC	MPSA45	Bipolar Transistor
Q4	600mADC-40VDC	2N4403	Bipolar Transistor
R1	1.5K-0.25W-5%	Carbon Film	Resistor
R2	5.6K-0.25W-5%	Carbon Film	Resistor
R3, 8	15K-0.25W-5%	Carbon Film	Resistor
R4, 11	10K-0.25W-5%	Carbon Film	Resistor
R5	15K-5W-5%	Wire Wound	Resistor
R6	39K-0.25W-5%	Carbon Film	Resistor
R7	3.3K-2W-5%	MO-2	Resistor
R9	4.7K-1W-5%	MO-1	Resistor
R10, 18	470 ohm-0.25W-5%	Flameproof	Resistor
R12, 15, 19	22K-0.25W-5%	Carbon Film	Resistor
R13, 16	.7K-0.25W-5%	Carbon Film	Resistor
R14	10K-0.33W-20%	Piher-PTC10YV	Jog Trimpot
R17	33K-0.25W-5%	Carbon Film	Resistor
R22	10 ohm-30W	Wire Wound	Brake Resistor
RY1	20A-110VDC	PBS87R11D2B1D1	DPDT Relay
SCR1	15A-600V	S6015L	Power SCR
Z1	7.5V-0.5W-5%	1N5236B	Zener Diode
Z2	75V-1W-5%	1N4761A	Zener Diode
Z3	22V-1W-5%	1N4748A	Zener Diode
CHANGES REQUIRED FOR APRM-2C—240V			
R7	10K-3W-5%	MO3	Resistor
RY1	20A-220VDC	PBS87R11D2B1D1	DPDT Relay
R22	20 ohm-60W	Wire Wound	Brake Resistor

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Manual Revision History

7/20/96 Revision 1.0 Included Appendix for Prodelin 3.8m

9/25/09 Added KPBP Operating Instructions.